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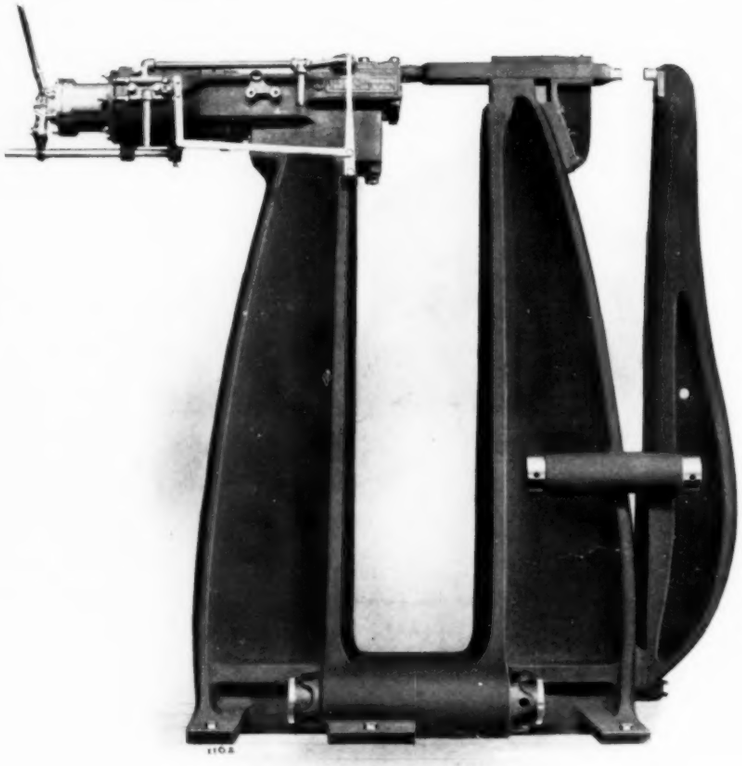

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

Principles of Running Balance

Editorial Correspondence

It is my privilege to present in this article results and conclusions from a few tests made on a Norton running balance machine. The principles of running balance are but little understood. Many wrong ideas are held and the usual explanation, mathematical or otherwise, is obscure. Therefore, it is not surprising that many things are done today in connection with the so called balancing of the parts of high-speed machinery that are unnecessary, ineffective and even positively detrimental.

The Norton machine has completely cleared up this subject, for by its use the principles that were formerly obscured are now demonstrated visually and are in the class of things that are believed because they are seen.

Principles of Balancing Machine Parts

The principles upon which this article is written and which were demonstrated by the tests, may be briefly stated as follows:

All rotating parts of high-speed machinery should be running balanced.

A part in running balance will also be in standing balance.

A part in perfect standing balance may be very far from being in running balance.

The operation of standing balancing may be a detriment instead of a benefit to high-speed machine parts.

A part in running balance at one speed will be in running balance at all other speeds, provided it does not distort from centrifugal action.

Exact symmetry of form is no guarantee of running balance.

High-speed parts should be so designed that they will not distort from centrifugal action if rotated free at any speed at which they may run in use and thus destroy a state of running balance.

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It is somewhat surprising to find the unsatisfactory way in which the average text book on machine design treats the subject of running balance. As a suggestion only, it seems as if the time is ripe for a more thorough investigation and for a more careful treatment of this subject. On the other side of the question, things are done today in our shops in the name of balancing, that are absurd. For instance, we find many manufacturers of machinery relying entirely upon standing balance for high-speeded parts of machines. We find others relying upon exact symmetry of form. We find others approximating running balance at a comparatively moderate speed, and without applying to the parts the forces to which they will be subjected in use. We find parts designed in such a manner that they cannot fail to distort from centrifugal action alone if run free at their operating speeds. It is high time, therefore, that the ideas of running balance in the shop be turned upside down and placed on a sound basis harmonizing theory and practice.

On page 1023 of Volume 32, Part 2, is a description of the Norton running balance machine. With the coöperation of the Norton Grinding Company a number of simple tests were made with a testing arbor, called in the shop "the porcupine."

The Test Arbor and Weights

This arbor is shown in the halftone illustration Fig. 1. It consists of a steel body 3¾ inches in diameter and about 16½ inches long, journaled down to 1½ inches and ⅝ inch on the ends, with a groove for the driving belt as shown, turned to a diameter of two inches. Radiating from this body are five sets of pins, or arms. These arms are ½ inch in diameter, 4 7/16 inches long from the body out, and spaced evenly. Weights were provided in the shape of cylindrical pieces of steel 1⅛ inches in diameter, 1 inch long, having a ½-inch axial hole and provided with a headless set screw in the side. See two of these weights in position on the arbor in Fig. 3. The purpose of the test was to study conditions of balancing and unbalancing, using this arbor and various arrangements of the weights.

At the outset the arbor was put in per-

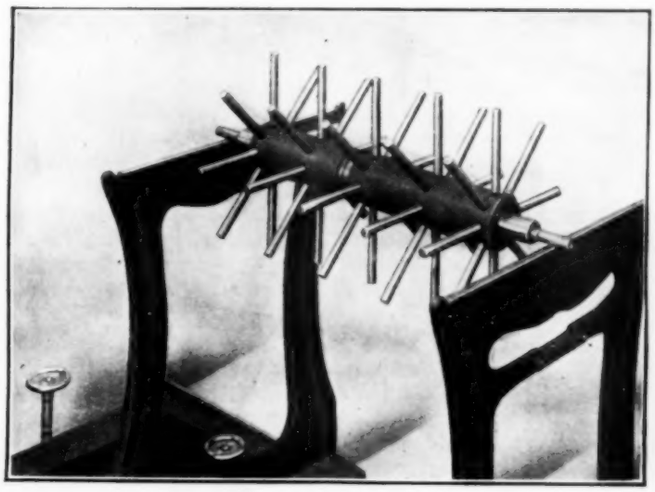

Fig. 1.

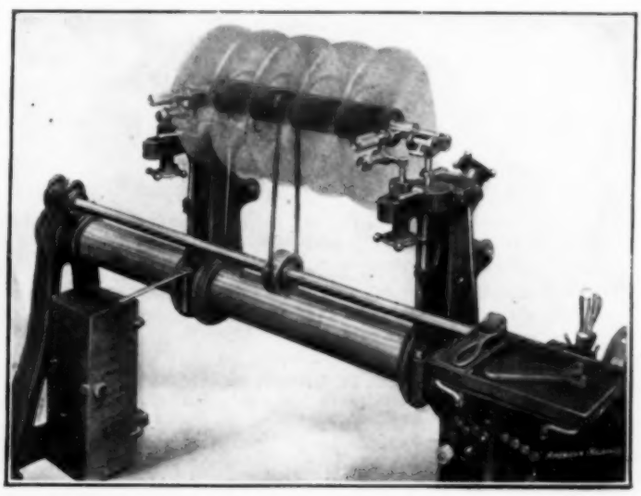

Fig. 2.

The Test Arbor in Static and Running Balance

fect standing and running balance. These conditions were photographed for the halftone illustrations Figs. 1 and 2. In Fig. 1 the arbor is shown on a Bowser standing balance machine, and in Fig. 2 is shown rotating at more than 1200 revolutions per minute in a Norton running balance machine. The first picture shows it at rest, or in equilibrium, on the horizontal balancing ways. The second shows it rotating at a high speed, and from the fact that the two pendulums of the machine did not vibrate, but were quiet, we see that the arbor is also in perfect running balance.

A Part in Standing Balance May Not Be in Running Balance

The first test that was made was to demonstrate that a part may be in perfect standing balance and, to use a shop expression "nowhere" in running balance.

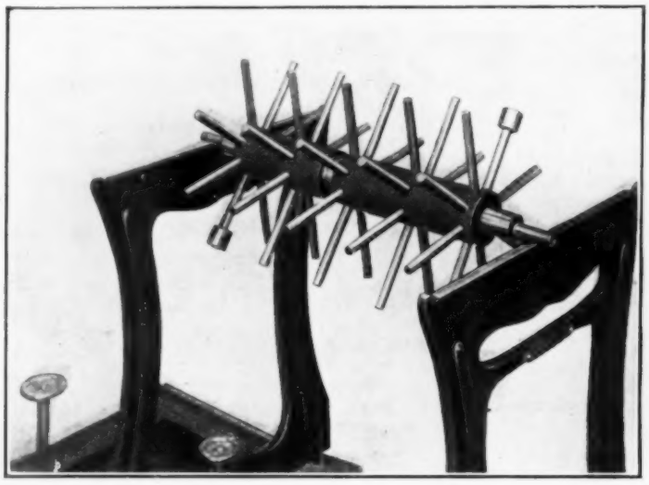

Fig. 3. Test Arbor in Static Balance, but Not in Running Balance

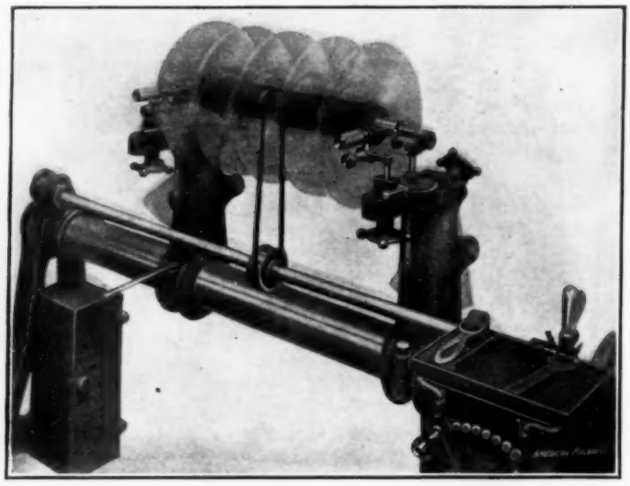

Fig. 4.

Two weights are put on the arbor, as shown in Fig. 3, so that the entire body, arbor and weights, was in perfect standing balance. The arbor was then transferred to the running balance machine, rotated at the slowest speed about 200 revolutions per minute—it was not run at a higher speed because we were afraid that it would jump out of its supports—and the vibration of the pendulum was so great that they show in Fig. 4 as a white blur against the machine uprights. Here the first halftone shows a condition of perfect standing balance, the second shows more pronouncedly a condition far from running balance.

The record of this test as shown in these illustrations, proves conclusively the absurdity of relying upon standing balance alone for the rotating parts of high-speed machinery.

Balancing the Arbor as Shown in Fig. 3

Taking the arbor as shown in Fig. 3 and recognizing that it is not in running balance, there are three ways in which it may be brought into running balance. The condition of unbalancing is caused by the two weights that have been added. It is evident that if we remove these weights the part will again be in running balance. It will also be accepted without argument that if we apply equal and opposite weights the structure will be in running balance. It is also true that the part can be put in running balance by applying weights which are either greater or less than those shown in Fig. 3, provided they are placed at a properly proportioned distance.

In the first experiment of this kind the arbor was balanced by applying four weights in the positions shown in Fig. 5. By way of explanation, in Figs. 5 to 13, inclusive, the unshaded weights were originally put on the arbor, and the shaded weights are the ones that were applied in order to establish running balance. The distances from the axis of rotation of the arbor to the centers of figure of the weights are given.

The first test consisted in balancing by means of four weights placed as shown in Fig. 5, and the second by four weights as shown in Figs. 6 and 7; that is, two weights placed on different arms but opposed to the original unbalancing weights.

Fig. 21 shows the perfect balance obtained by an arrangement of weights as in the diagram, Fig. 5, while Fig. 22 shows the perfect balance again obtained by a distribution of weights as shown in Figs. 6 and 7.

It is obvious that greater or less weights properly located, would have accomplished the same results, provided they had been placed at a distance from the axis of rotation in inverse proportion to their magnitude.

Balancing an Arrangement of Weights in Three Planes of Rotation

Fig. 8 shows in diagram an unbalanced condition brought about by placing three weights on the test arbor. This was looked upon as a difficult arrangement to put in running balance. As a matter of fact, it was found to be comparatively easy, and Figs. 9 to 13, inclusive, show five arrangements of different numbers of weights, all of which brought about perfect running balance.

Fig. 23 shows the arrangement of Fig. 8, and it is seen to be badly out of balance. The pendulums merely show as a white blur. No photographs were taken of the conditions from Figs. 9 to 13, inclusive, as it will be recognized that all such photographs would have looked alike and would have failed to add interest or value to this article. At the same time each one of the conditions illustrated by those diagrams was proved to be in perfect running balance and also in perfect standing balance.

Turning again to these diagrams it will be noted that the condition of unbalance represented by Fig. 8 is balanced in Fig. 9 by three weights, in Fig. 10 by four weights, in Fig. 11 by four weights—differently spaced than those in Fig. 10—in Fig. 12 by one weight, and in Fig. 13 by two weights. There are many other combinations that might have been used, but these that are shown are sufficient for the purpose of demonstrating the principles involved. All of the weights indicated in the diagrams, Figs. 8 to 13, inclusive, were in the same plane. It is evident that there would have been no change in principle if the weights had not been all in the same plane; although their magnitude and position would have been different, in order to bring about a corresponding condition of running balance or lack of such balance.

Standing Balance

A part free to rotate, but otherwise restrained, is in standing balance when the algebraic sum of all the gravity moments of the forces about the axis of rotation is zero. This simply means in connection with the arbor and its

weights, that the sum of the products of the weights and the distances from their center of gravity to the axis of rotation on one side, must be equal to the sum of the products of the weights and their distances from the axis of rotation on the other side. The weights used weighed about 0.22 pound each. The following arithmetical statements show that the combination of weights in Figs. 5 to 13, inclusive, are in standing balance.

From Fig. 5 we have:

$0.22 \times 5\,5/16 + 2\ (0.22)\ 2\frac{5}{8} = 0.22 \times 5\,5/16 + 2\ (0.22)\ 2\frac{5}{8}$, or $2.323 = 2.323$.

From Figs. 6 and 7:

$0.22 \times 5\,5/16 + 2$ sine, 45 degrees $(0.22)\ 3\,51/64 = 0.22 \times 5\,5/16 +$ 2 sine, 45 degrees $(0.22)\ 3\,51/64$, or $2.349 = 2.349$.

The condition shown by Fig. 9 is obviously in standing balance, for there are three weights on each side of the axis of rotation and all at the same distance therefrom.

Turning now to Fig. 10,

$3\ (0.22)\ 5\,5/16 = 2\ (0.22)\ 5\,5/16 + (0.22)\ 2\frac{5}{8} + (0.22)\ 2\,11/16$, or $3.506 = 3.506$.

Considering Fig. 11,

$2\ (0.22)\ 5\,5/16 + 2\ (0.22)\ 1\,29/32 = (0.22)\ 5\,5/16 + 2\ (0.22)\ 4\,9/16$, or $3.176 = 3.176$.

From Fig. 12,

$(0.22)\ 4\,29/32 + (0.22)\ 5\,1/16 = 2\ (0.22)\ 4\,13/16$, or $2.193 = 2.181$. (?)

From Fig. 13,

$2\ (0.22)\ 5\,5/16 = (0.22)\ 5\,5/16 + (0.22)\ 2\frac{5}{8} + (0.22)\ 2\,13/32$, or $2.338 = 2.275$. (?)

In the last two illustrations, those referring to Figs. 12 and 13, it will be noticed that equality is not shown by the final figures. The trouble lies with the measurements and not with the underlying principles. When it is stated that the arbor and its pins, and the accompanying weights were well made, but within the limits of commercial accuracy and not laboratory refinements and that all of the measurements were made with a steel scale to thirty-seconds of an inch, it is, perhaps, surprising that any of these tests should check mathematically, rather than that two of them do not.

Running Balance

The conditions of running balance for a rotating part are expressed by the statement that the algebraic sum of all the centrifugal forces acting upon the body must be zero, and the algebraic sum of all the moments of the centrifugal forces about every axis in the plane of rotation must be zero.

This means that unbalancing may be produced either by an unbalanced centrifugal force or unbalanced centrifugal couple.

If a wheel or shaft or other machine part has its center of gravity lying outside of the axis of rotation, a pressure is brought upon the bearing equal to the centrifugal force set up by this unbalanced revolving weight. This force puts a stress upon the bearing, in addition to those that the bearing has to resist from the weight of the parts and the pulls or thrusts of the gears, belts, etc., acting upon the part, whether it is actually rotating or not. This centrifugal force is continually changing its direction as the part revolves and has a tendency to set up vibrations in the supporting members of the machine.

A centrifugal couple is made up of equal and opposite centrifugal forces lying on either side of the plane of rotation. Fig. 14 shows diagrammatically the couple acting in experiment one, see Figs. 1 and 2. The effect, or tendency, of such a couple is to make the frame of the machine shake or "wabble."

Fig. 15 diagrams the forces acting upon the test arbor from the weights as placed in Fig. 8. Here the single weight on one side of the axis of rotation taken in connection with one-half of each of the two weights on the other side of the axis forms two equal and opposed couples, which have no effect in destroying the running balance of the test arbor. But the remaining half of each of the two weights form an unbalanced centrifugal force that throws the part out of running balance.

Thus the condition shown in Fig. 15 is one of unbalancing because of the centrifugal couple, and the condition shown in Fig. 14 is one of unbalancing due to centrifugal force.

Referring to the diagrams, Figs. 9 to 13, inclusive, the centrifugal forces set up by revolving weights resolve themselves into two couples equal and opposed, one lying on either side of the plane or rotating, which is assumed as passing through the center row of pins in the arbor. Figs. 16 to 20, inclusive, show these couples. The resolved weight is indicated by the letter W and the distance from the center of the figure to the axis of rotation by a dimension expressed in inches. The arms of the centrifugal couple expressed by the distances $A\,B$ and $C\,D$ in each figure are equal for each condition. They are not expressed here in inches.

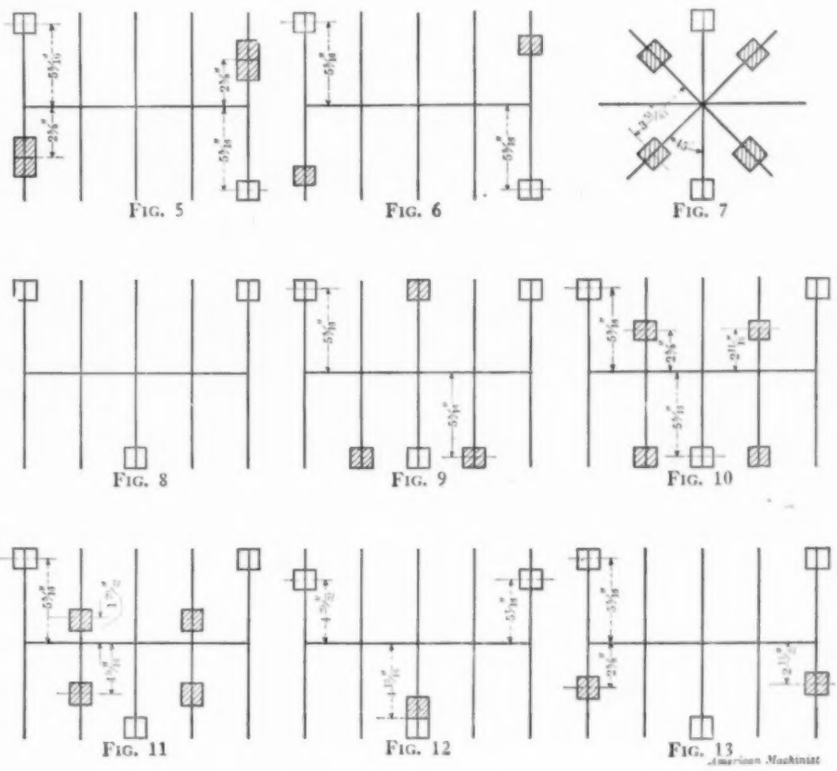

Fig. 5 Fig. 6 Fig. 7

Fig. 8 Fig. 9 Fig. 10

Fig. 11 Fig. 12 Fig. 13

Diagrams Showing Weights Added to Test Arbor

A study of these diagrams will show that the couples are approximately equal, and that they are opposed in direction, and produce running balance. The fact that they are not absolutely equal is undoubtedly due to errors of observation and measurement.

Experiments with Machine Parts—Flywheels

Turning now to a few experiments in the actual balancing of machine parts, several important facts have been brought out. To begin with, it was desired to ascertain how little weight could be detected by the machine. Several experi-

ments were carried out, leading to this observation, that ¼ of an ounce at a distance of 5½ inches from the center of rotation, at a speed of 660 revolutions per minute, was very perceptible in the vibrations of the pendulums.

An automobile engine flywheel was balanced which was 19 inches in diameter, with a rim 2¼ inches wide and 1¾ inches thick. The weight of the wheel was approximately 75 pounds. The wheel had eight arms. Before balancing at a speed of 1200 revolutions, the pendulum had a vibration at the tip of about 1/16 of an inch. Four spots were drilled into the flywheel rim with a 7/16-inch drill fed into the body side. The removal of this very small amount of metal was sufficient to put the flywheel in perfect running balance as indicated by the running-balance machine.

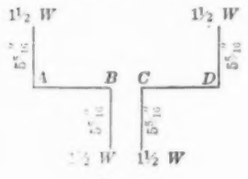

FIG. 16

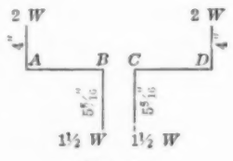

FIG. 17

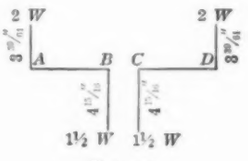

FIG. 18

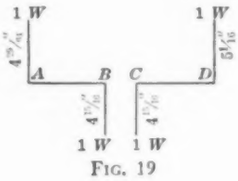

FIG. 19

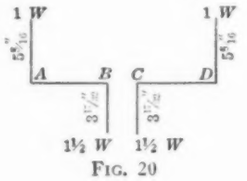

FIG. 20

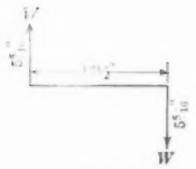

FIG. 14

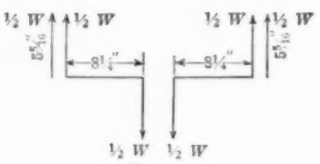

FIG. 15

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DIAGRAMS OF CENTRIFUGAL MOMENTS AND COUPLES FROM WEIGHTS ARRANGED AS IN FIGS. 5 TO 13 INCLUSIVE

The unbalanced condition of a flywheel rim may be as shown diagrammatically in the upper right-hand corner of Fig. 24 where the second and third sets of pins of the testing arbor can be considered as the edges of a flywheel and the two weights as heavy spots. When the photograph was taken from which the halftone was made, the arbor was weighted as shown in the accompanying diagram. Its condition of unbalancing is seen from the white blur indicating the travel of the pendulums.

To show that standing balancing alone may be a positive detriment consider Fig. 25. In diagram this represents the rim of a flywheel having three heavy spots, *A*, *B* and *C*. If a flywheel with a rim in this condition should be placed on a set of balancing ways the side marked *B C* would swing to the bottom and be recognized as the heavy side. The workman might balance the wheel statically by drilling into the side of the rim at the point indicated as heavy. Not knowing the relationship of the heavy spots he may drill at *B* and remove enough metal so that *C* and *A* balance each other and the flywheel be in perfect standing balance. Refering to Figs. 3 and 4, the first experiment made with the arbor, it is evident that while this course would produce perfect standing balance, the running balance would be worse than before any attempt at balancing was made.

CRANK SHAFTS

Several experiments were tried with automobile crank shafts, and this important fact was plainly observed. After a crank shaft had been put into running balance at reasonable speeds, if it was speeded up beyond a certain critical speed, the action of centrifugal force upon the sections of the crank shaft that are not directly opposed by other similar sections, causes the shaft to bend and it is thrown out of running balance. By turning to Fig. 26 the effect is that the dotted V tends to close, as the heavy mass at the point *A* is thrown outward by centrifugal force, thus a condition of running balance is lost.

Too great emphasis cannot be placed upon this fact for it is useless to balance parts carefully only to have them promptly thrown out of balance when the part is put into use and is acted upon by the forces to which it is subjected at working speed. It is doubtful if many automobile crank shafts of today fulfil this requirement of running balance.

Consider for a moment a four-throw crank shaft (see Fig. 27). The bearings marked *X* are unrestrained, and in the running balance machine it is mounted on the bearings marked *A*. If this is put in running balance at a moderate speed and then speeded up to 1200 revolutions per minute, centrifugal force acting upon the center cranks in one direction and upon the end cranks in the other direction, is sufficient to throw this shaft out of running balance.

Mr. Norton sums up his experience in this connection as follows: "We have discovered that no automobile crank shaft constructed in the ordinary way will run at any reasonable speed without bending. That is, when in service in the automobile the bearings in the frame of the engine are obliged to resist the bending action of the shaft at anything like high speeds. A speed of two or three hundred turns per minute does not bend an ordinary four-throw shaft. However, as the speed rises above that amount to, say, 1200 revolutions per minute or more, the shaft of the ordinary four-cylinder engine, as we see them here, bends when revolving without restraint something like 1/16 inch."

Another important lesson was taught by a six-throw crank shaft made by one of the foremost automobile builders of this country. This was most carefully machined all over within extremely close limits, with the idea that thereby a balanced crank shaft is produced. This shaft was put into the testing machine, and instead of showing that the refined machine work had accomplished its purpose, it was found that the shaft was very much out of balance; in fact, several ounces of metal had to be removed in order to get it into a condition of running balance. The refined machine work was unavailing in spite of the fact that the sections of metal on either side of the axis of rotation were of the same dimensions and at the same distances from the axis. The shaft was not in running balance. It is probable that if a small amount of the time spent in unnecessary machine work on this shaft had been spent in intelligent balancing the final result would have been far superior. The refined machine work, which was supposed to give running balance, is undoubtedly an excellent talking point to the non-technical, or even technical, automobile buyer; but as a process in machine construction it is worthless for the purpose intended.

As a matter of interest, another observation in connection with balancing a four-throw crank shaft is worthy of mention. Statically this shaft showed heavy on the end-throw side. At a low speed in the running-balancing machine the scriber marked the shaft at the flange end on the heavy side, or end-throw side. At a little higher speed the pendulums began to shorten their vibrations, finally stopped, and began to vibrate again violently, indi-

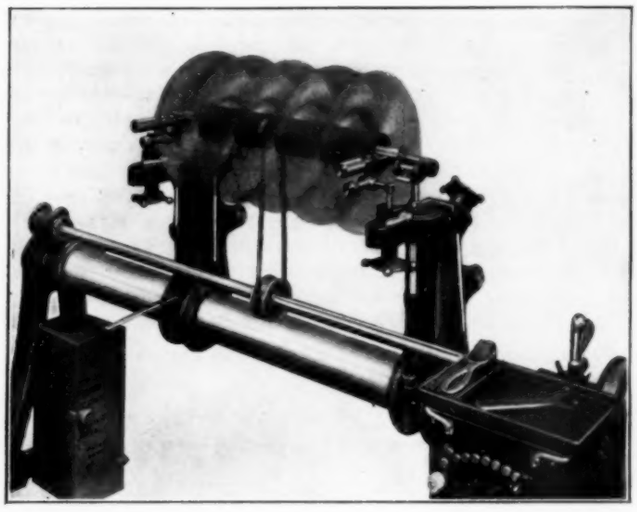


FIG. 21. PERFECT RUNNING BALANCE OF TEST ARBOR WITH WEIGHTS ARRANGED AS IN FIG. 5

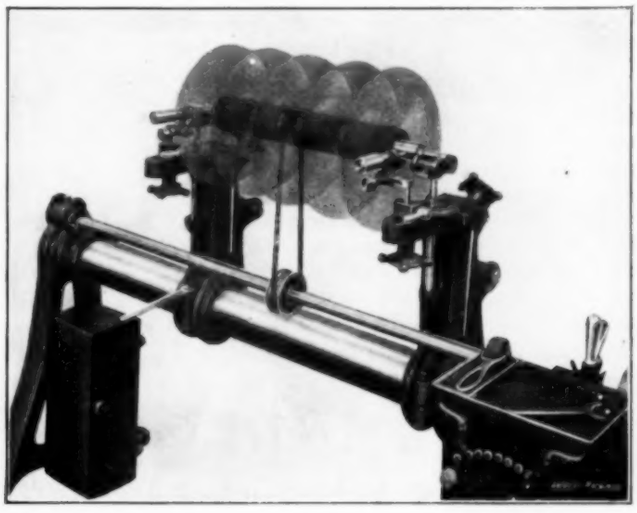


FIG. 22. PERFECT RUNNING BALANCE OF TEST ARBOR WITH WEIGHTS ARRANGED AS IN FIGS. 6 AND 7

cating that a critical speed had been passed. After this change in the movement of the pendulums was noted, it was found that the shaft marked on the side directly opposite from the first mark; that is on the light side, or side opposite the end-throw cranks.

If a part that is not in running balance is rotated about its center of mass, it is evident that the lighter side must rotate in a larger circle than the heavy side. To show this refer to Fig. 28, which represents a disk, one edge of which is much heavier in proportion than the balance of the figure. The center of the disk is at O, and the center of mass at P. If this disk revolves about the center of mass it is evident that the light side will travel in a circle having a radius r, while the heavy side will rotate in a circle having a radius r_1; r is greater than r_1. Thus in a body out of balance and rotating freely about its center of mass, the light side will describe a circle larger than the heavy side. For that reason the scriber in the running-balance machine will mark a rotating object on the light side, provided it is rotating about its center of mass.

From this reasoning we observe in regard to the four-throw crank shaft, that when it was rotating at a low speed, it was rotating about an axis that did not pass through either the center of figure or the center of mass, but lay between the center of figure and the light side of the shaft. After a certain critical speed had been passed the axis of rotation shifted from its first position to a position more nearly intersecting the center of mass and the shaft marked on the light side.

The reason for this changeover probably lies in the synchronizing relation between the rotating shaft and its supports. At the lower speed the restraining action of the support is sufficient to overcome the unbalanced force of the shaft and cause the vibration to have its mid point on an axis of rotation that is neither the axis of figure nor an axis of passing through the center of mass of the rotating shaft. As the speed increases the unbalanced force of the shaft increases, and tends to approach the restraining force of the supports until they are equal. At this speed the axis of rotation and axis of figure of the shaft coincide, the centrifugal force and the restraining force are equal and opposite, and the pendulum ceases to vibrate, or in other words, the combined system of shaft and supports is in running balance.

As the speed increases the centrifugal unbalanced force of the shaft becomes greater than the restraining effect of the supports, and the shaft tends to rotate about its center of mass, thereby increasing the vibrations of the pendulum and causing the scriber of the machine to mark on the light side. It is probable that if there was no restraining action whatever the shaft would rotate at even the lowest speed around an axis through

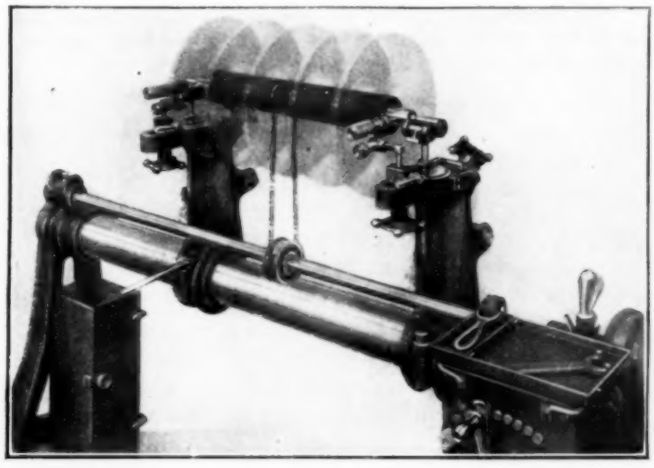


FIG. 23. LACK OF RUNNING BALANCE OF TEST ARBOR WITH WEIGHTS ARRANGED AS IN FIG. 8

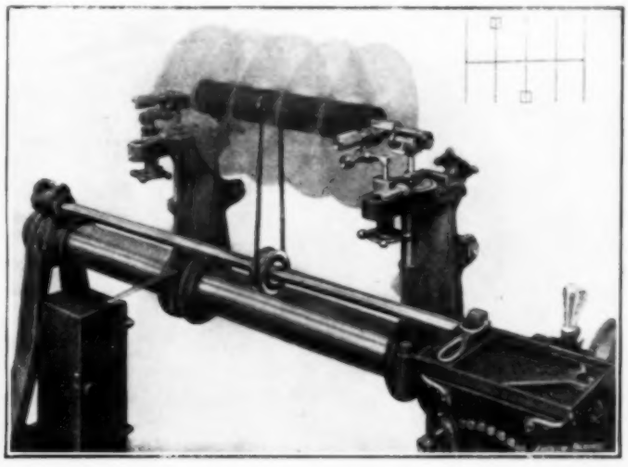


FIG. 24. LACK OF RUNNING BALANCE OF TEST ARBOR WITH AN ARRANGEMENT OF WEIGHTS COMPARABLE WITH A COMMON FLYWHEEL CONDITION

its center of mass, and thereby the scriber would mark on the light side.

This most interesting phenomenon was something that Mr. Norton did not anticipate, in connection with his machine, and we have introduced it here as a matter of interest largely, although it may have some effect in explaining a condition that is often noted in connection with machine parts that are out of balance. Many of us have watched a high-speed machine as it was slowed down and stopped. Frequently as the speed

FIG. 25. DIAGRAM OF RIM OF FLYWHEEL

dropped, some member would begin to pound furiously, producing much more vibration than when running at its normal speed. The usual idea in such a case is that the part in question was unbalanced at the slow speed and was in balance at the high speed. We know that this idea is erroneous, however, provided the part does not distort from centrifugal action. In fact, referring back

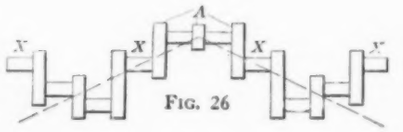


FIG. 26

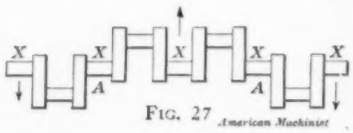


FIG. 27 *American Machinist*

DIAGRAMS OF AUTOMOBILE-ENGINE CRANK SHAFTS

to the tests in the earlier part of this article, after the test arbor had been put in balance it was run through the entire range of speeds on the balancing machine and was found to be equally in balance throughout this range. Most of the photographs taken of the parts in running balance were taken at the highest speed on the machine; namely, 1200 revolutions per minute.

It is quite likely that the facts observed in connection with these high-speed machine parts were merely caused by synchronizing or lack of synchronizing between the rotating parts and the machine frames that held them.

In closing, a word must be said about the importance and novelty of the pendulum action of Mr. Norton's machine. To the best of my knowledge, previous running-balance machines have had no provision for the free shaking of the part under test, it being necessary for the part to overcome the resistance of the supporting frame, together with the inertia of the mass of this frame before vibrations are set up. What he has done with this pendulum construction and the light supporting parts of the piece under test, is to make it easy, instead of difficult, for the part under test to show to the eye that it is out of balance.

The day of standing balance for high-

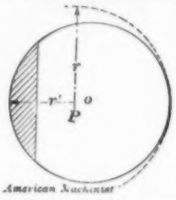


FIG. 28. RELATION OF CENTER OF FIGURE AND CENTER OF MASS OF UNBALANCED BODY

speed machine parts has passed. The uptodate manufacturer must recognize the principles of running balance and apply them, and the machine-building world should be grateful to Mr. Norton for having developed a machine whereby the principles of running balance can be demonstrated visually, and parts can be put in perfect running balance.

L. P. A.

Machinery Trade in United Kingdom

Of the preliminary tables summarizing the results of returns received under the British Census of Production Act, and the accompanying report, as submitted to Parliament during the last session (1910), part 2 is of particular interest to manufacturers of machinery in the United States, as it presents a clear and concise description of the present state of the machinery trade in the United Kingdom, showing the value of the output and the capacity of the manufacturing establishments.

The tables in part 2 of the report include the production of the shipbuilding yards, engineering factories, machine manufacturing establishments, leather and paper factories, cycle and motor factories. About 13,000 schedules were issued to firms engaged in these industries, which employed in 1907 an average of over 750,000 persons, and produced a total output which represented a net addition of over £80,000,000 sterling to the value of the materials used. In the case of shipbuilding, information is also given with regard to the output of government dockyards and the repairing shops under the control of public lighthouse authorities. The figures shown with regard to these branches of the industry, which gave employment in 1907 to an average of 25,000 persons, are necessarily not exactly comparable with those furnished by private firms, as they are on a basis of cost of production and do not include the element of profit.

The period to which the tables relate is generally the year 1907, but where the financial year of a firm is not the calendar year, the firm has been permitted to furnish particulars for a period of 12 months ending not earlier than June 30, 1907, nor later than June 30, 1908. The returns for government shipbuilding yards were furnished for the 12 months ending March 31, 1908.

The tables cover the following points on which the Census of Production Act required information to be obtained: Output, cost of materials used, amount paid to other firms for work given out

	Gross Output, Selling Value. (1)	Materials Used, Cost. (2)	Work Given Out. Amount Paid to Other Firms. (3)	Net Output, Excess of Column (1) over Columns (2) and (3). (4)	Persons Employed, Total. (5)	Net Output per Person Employed. (6)
	£	£	£	£	£	£
Shipbuilding yards and marine engineering works (private firms)	41,660,000	17,895,000	6,087,000	17,678,000	184,557	96
Engineering factories (including electrical engineering and machine manufacturers)	101,599,000	48,323,000	3,851,000	49,425,000	455,561	108
Cycle and motor factories	10,643,000	5 063,000	181,000	5,399,000	46,800	115
Leather factories (tanning and dressing)	17,551,000	13,872,000	58,000	3,621,000	27,258	133
Paper-making factories	13,328,000	8,816,000		4,512,000	39,990	113
Total	184,781,000	93,969,000	10,177,000	80,635,000	754,166	...
Shipbuilding, government yards and lighthouse authorities	6,459,480	3,961,412		2,489,068	25,058	99

to them, and the number of persons employed.

The "output" shown in the tables is the gross output of each trade, i.e., where goods pass through the hands of several manufacturers at different stages, their quantity and value has been registered at each stage. The value of this gross output is, therefore, greater as a whole than the value of the goods ready for export or consumption manufactured by each trade considered as a unit.

The result of deducting the total cost of materials used and the amount paid to other firms for work given out from the value of the gross output for any one industry or group of factories is to give a figure which may, for convenience, be called the "net output" of the industry of the group. This figure expresses completely and without duplication the total amount by which the value of the products of the industry or group taken as a unit exceeded the value of the materials purchased from outside, i.e., it represents the value added to the raw materials in the course of manufacture. This sum constitutes for any industry the fund from which wages, salaries, rents, rates, taxes, depreciation, and all other similar charges as well as profits have to be defrayed.

The accompanying short statement shows for the United Kingdom as a whole the gross output, the cost of materials used, the amount paid for work given out to other firms, the "net output" as above defined, the number employed, and the net output per person employed.

Elastic Limit by Temperature*

Editorial Correspondence

A useful application of the well known principle that when material is stretched within its elastic limit, the test piece becomes colder, by a definite law, and upon release of the tension stress, the temperature of the test piece again rises to normal.

*Translated from paper presented by E. Rasch before the Copenhagen Congress of the International Society for Testing Materials, through the courtesy of the Hess-Bright Manufacturing Company.

In February, 1908, Prof. A. Martens, of the Royal Prussian Academy of Sciences, put before his physical-mathematical class a method of determining the elastic limit of materials by temperature changes, which was worked out in the Royal Material Testing Office at Berlin-Gross-Lichterfelde.

It has been known for a long time that when material is stretched within its elastic limit, the test piece becomes colder, by a definite law, and upon the release of the tension stress the temperature of the test piece again rises to normal. If the stretching is continued beyond the elastic limit of the material, a sudden heat change occurs and the falling temperature is replaced by a distinct rise.

These phenomena have been studied and written about by numerous prominent men, such as Lord Kelvin, Clausis, Joule, Edlund, Haga, Wachsmuth, and others, and their researches have indicated that the heat changes taking place when material is stretched within its elastic limit and then released, are in the nature of a closed cycle. It also has been stated by Dulong-Petit that the product of the atomic weight and the specific heat, for all metals is constant, and this is recognized as an evidence that there is a simple thermodynamic law connecting the elastic strength, the molecular construction and the heat properties of all metals.

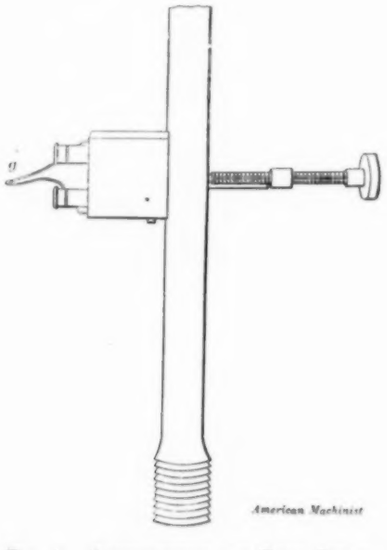


FIG. 1. INSTRUMENT ON TEST PIECE

Until recently no useful application of this principle was found. Its useful application at the present time is due to a desire to find some easily operated method of accurately determining the elastic limit of such materials as cast iron, where the location of this point by the curve of stress and elongation is very difficult. Until recently also, most of the exeriments in this work have been calorimetric or quantitive determinations of heat, rather than instantaneous readings of temperature change.

Fig. 1 shows an instrument which is now said to be perfected for the determination of elastic limits by temperature changes, the active agent being a series of thermoelectric couples held inside a hard rubber box, the couples being located in a narrow, lengthwise slit in the middle, close to, but out of contact with the surface of the test piece. Electric currents generated by the heat changes acting upon the couples are led to a sensitive galvanometer, by which the temperatures are noted as the test piece is stretched. In Fig. 2 a number of curves are reproduced, showing the temperature changes with increasing tension and in all cases it will be noted that a sharp angle in the curve occurs at the elastic limit. It is at this point that the work done by the testing machine exceeds the work absorbed in elastically stretching the material and the temperature rise is the result of the internal friction of the molecules sliding past each other as permanent stretching is produced.

The test piece in this case was a brass rod. In curve *a* the rod was annealed, while in *b*, *c*, *d*, *e* and *f* the elastic limit was increased by previous straining. In making these tests the indicator of the

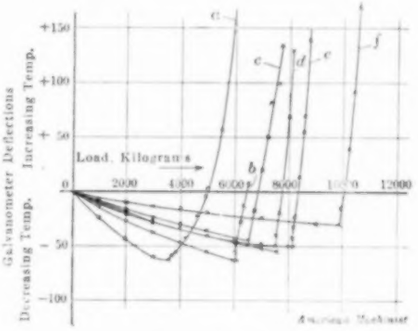


FIG. 2. CURVES SHOWING ELASTIC LIMIT BY TEMPERATURE CHANGE

ordinary testing machine showed no definite elastic limit point, while the galvanometer of the thermoelectric couple showed this point in every case by the sharp turn in the curves. In the case of cast-iron test pieces, this turn did not occur until the moment of breakage.

It is also said that the thermoelectric method has proved very satisfactory for determining the stress distribution and the position of the neutral axis, in bending tests. This was done by arranging the thermoelectric couples at various hights of the beam cross-section, and as the fibers under tension decreased in temperature, the location of the neutral axis was quite easy. It was also found in bending tests of broad-flanged, shallow beams, the neutral axis was shifted very considerably toward the tension side.

Car-motor Ideal Lubrication

By Hugh Dolnar

A review of the various systems of lubrication for automobile motors, which have been developed to keep pace with the increasing complications of engine design. The mechanical oiler with its adjustable, restricted oil outlets to each bearing is subject to clogging and requires frequent adjustment to load and speed. The continuous oil circulating system, with simple pump, low and high level reservoirs and settling basin, comes nearest to ideal. A new safety drain plug to guard against accidental opening and loss of oil.

Ideal lubrication, the best possible oiling for the car motor, is the prime requisite of motor-car satisfactory operation, because a small high-speed gas engine will destroy some vital part in a very few minutes after abundant lubrication ceases.

The fuel supply, the ignition and the lubrication of the motor are the three factors of motor-car propulsion, and it is quite correct to place oiling at the head of the list.

Because of this, hundreds of inventions, some of them plausible, many highly ingenious, and none, as yet, entirely faultless, have been made in car-motor oiling devices.

The first car motors to come into large use were single-cylinder horizontal gas engines not difficult to oil, as shown in Fig. 1. Between this simplest of all car motors, which, by the way, is now being again advocated as best possible for ordinary motor-car work, and the vertical multi-cylinder motor, there are such differences as to make an elaborate and carefully designed oiling system an imperative necessity. The second form of motors much used was the opposed cylinder type, which could be oiled the same as in Fig. 1.

Next came the 4-cylinder vertical motor, with 2 cylinders and 3 cylinders vertical as variations not largely used.

The vertical-cylinder motor with the multithrow crank shaft, one or two cam shafts, some gears and valve lifters and other adornments to oil, has become another story altogether and the oiling problem has had many new conditions added so that with the introduction of these engines the "mechanical oiler" became at once a very generally accepted element of the car motor, continuing in high favor for some years as the best possible solution of the motor-oiling problem.

In brief, the mechanical, or "precision" oiler is based on the theorem that each friction point of the motor should be reached by an oil lead; commonly, in the early days, a ⅛-inch brass or copper tube, and that this oil tube should be supplied with a measured quantity of oil at frequent intervals. In very few instances, if any, was the oil returned to the lubricator. What went to the bearings was supposed to be "worn out" in actual service, and was in practice dripped finally into the crank pits, drawn off and thrown away, because it was full of grit, thick and dirty, if, indeed it was not dripped on the road surface as the car ran along, and so wasted.

The fatal objections to the mechanical oiler are, first, the restriction of the delivery opening which must be extremely small to prevent unendurable oil waste, and hence must be subject to stoppage by particles of dirt, and, second, the nonreturn of the oil.

Each of the 12, 10 or 8 oil leads had its own individual delivery adjustment of some sort, and a car-oiling system carefully adjusted to pavement-surface requirements was certain to give trouble if driven hard over country roads, necessi-

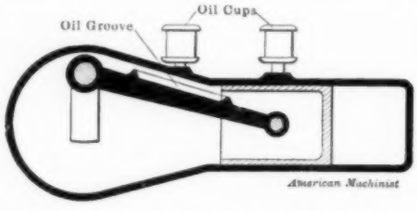


FIG. 1. HORIZONTAL MOTOR OILING

tating frequent delays for readjustment of oil-lead needle valve screws. This fault of restricted oil-delivery openings is now fully understood, though this general knowledge does not prevent the use of mechanical oilers on many fine cars, whose builders cannot yet make up their minds to introduce the costly changes needed for ideal oiling.

The second bad feature of drip oiling, with no return of lubricating oil, is the waste of oil inseparable from the nonreturn system. I do not believe that lubricating oil can be worn out. Oil can carry dirt that makes it unfit to lubricate a bearing, and can be supplied to bearings so that it runs away and is lost entirely, but I never saw an instance where it was conclusively shown that lubricating oil was actually worn out by service in friction reduction.

Besides dirt stoppage and oil waste the thicket of oil piping incident to mechanical-oiler employment is highly objectionable, not only because of first cost and fragility, but because it is so much in the way when the motor requires attention.

The mechanical-oiler drip oiling also includes the crank-box "splash," which consists of a pool of oil of varying depth maintained in the bottom of the crank pits, into which the rod ends dip at each revolution, creating a penetrating oil mist. This is often relied upon to oil the pistons, the crank-shaft bearings, the cam shaft, cams and valve lifters of a vertical cylinder motor.

Because this oil mist is so finely divided and mingled with air in violent motion, it follows that the oil is most efficiently exposed to atmospheric oxygen, which speedily thickens heavy lubricating oils, so that, as is well known, chain and ring oiling fail when used with pure lard oil, or any of the very heavy lubricating oils. This is admitted to be a bad fault.

BALL BEARINGS

Since motor oiling is so difficult, and so badly performed by common practice, should ball bearings be installed wherever practicable in the small gas engine? Experience of long and careful trial seems to prove that ball bearings should not be applied to the crank shaft because of the heavy explosion blows and the piston and cylinder do not permit ball bearings. Moreover, the best plain bearings, steel shafts and antifriction boxes, with best lubricants show but 1½ per cent. more friction loss than the best ball bearings, in carefully conducted laboratory tests, so that the greater expense is not warranted.

WHAT IS THE OILING LESSON, SO FAR?

First; the use of heavy lubricating oil, so as to employ the most efficient friction-reducing agent.

Second; unrestricted oil ways to each friction point, not less than ⅛ inch diameter clear opening, and more diameter preferred.

Third; elimination of all separate oil piping because of fragility, cost, obstruction, waste of time in taking down and replacing and unsightliness.

Fourth; seclusion of the oil from atmospheric exposure as much as may

be, because of oxidation and dust carrying.

Fifth; return of lubricating oil to the oiling system after it has passed through the motor journals and other sliding-friction creating constraints.

In some of the best cars the mechanical oiler with its adjustments and piping have been replaced by a pump and overhead oil reservoir with gravity oil feeding through large unobstructed oil ducts to lubrication points, the oil finally descending to the crank pits and flowing over dams to a settling basin and then to the returning oil-pump well, all with entire satisfaction.

Again, in some car motors now made, oil piping is replaced by oil passages in the walls of the motor structure. This method of oil distribution is the best possible, but must, of course, be made a feature of the original motor design, and calls for much care and ingenuity on the part of the designer.

What Are the Probabilities of Future Practice?

Up to 1909 no American motor-car constructor made even a fair attempt at complete exclusion of dust from the entire propulsion plant, while up to the time of this writing no car has been offered for sale in which all of the spring and control joints and sliding surfaces were inclosed or otherwise made dust proof. In many cases, where heavy grease cups with screw caps are fitted to supply central grease ducts, the grease travels outward by the action of the joint and so tends to exclude the dust, and it is possible that this manner of lubrication will continue to be regarded as satisfactory for slow-moving joints.

For piston and cylinder and connecting-rod lubrication of the trunk engine, nothing but splash and oil-mist distribution of fluid oil has been attempted and probably nothing else ever will be attempted, because the oiling must be continuous so long as the motor is running and the surfaces to be oiled cannot be reached save by having the whole interior of the crank box and piston filled with air and oil mist.

As might have been expected, the old style hand-supplied crank-pit oil splash pool worked well at times and yet often caused trouble, delay, and costly repairs from neglect to fill, and the presence of grit leading up to the mechanical oiler of various forms.

The mechanical oiler was based on the generalization that every point of lubrication should have its own individual oil lead conveying to it exactly the measured quantity of oil suitable for its demands.

Analysis of conditions and requirements shows this assumption to be wholly erroneous. The crankshaft and connecting-rod bearings, the gears, cam-shaft and the whole cam action are better for flooded lubrication and cannot have too much oil delivered to them. The piston and cylinder alone can be oiled too much, and they only because of plug sooting, waste of oil and smoky exhaust. But the cylinder and piston oiling may be either by a properly proportioned circumferential oil groove cut in the cylinder at a place always covered by the piston, or the piston and cylinder may be oiled by the oil mist, the density of this oil mist being proportional to the depth of the dip of the connecting rod below the surface of the splash pool. Therefore it is only needful to regulate the splash-pool level by a dam at one side and provide an oil drainage from the dam to hold an oil-flooded splash-pool at so nearly a constant level that satisfactory cylinder and piston oiling will be assured with no chance for sufficient over oiling to produce smoky exhaust.

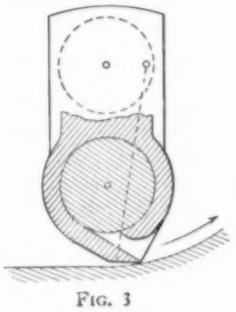


Fig. 3 Rod and Wrist Splash

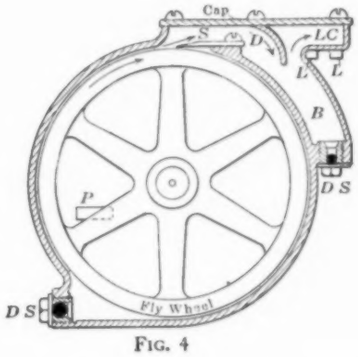


Fig. 4 Flywheel Oil Pump

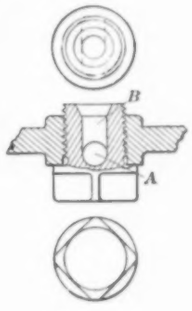


Fig. 5 Drain Screw

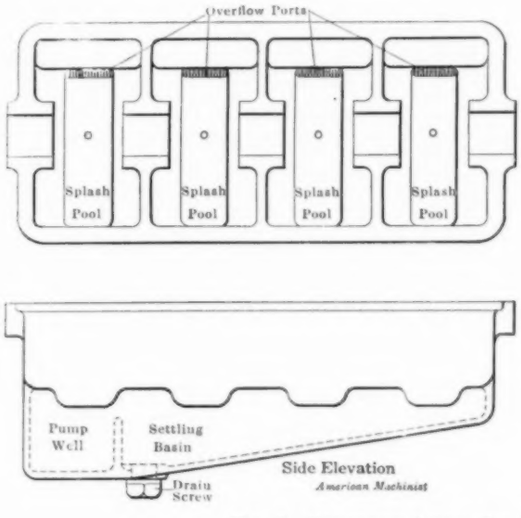


Fig. 2. Constant Level Oil Splash

Oil Circulating Elements

The notable points of variation in the oil-circulating systems so far shown are to be found in the forms of oil elevators, the oil-supply indicators and the drainage cocks used.

The pump may be a reciprocating plunger or a two-pinion rotary; as the lift is very low and the discharge into the high-level reservoir is unobstructed, the pump is subjected to very little wear and should be durable. In two instances, or more, no pumps of ordinary form are used; the flywheel is wholly incased and the bottom of the flywheel casing is made the low-level reservoir; the flywheel rim picks up the oil and carries it to the top of the flywheel where the oil is taken off by a scraper, set so as to just clear the flywheel, and delivered to the high-level reservoir. Fig. 4 shows such an arrangement; the details of which are original with me, though they may have been used by others.

Naturally the settling basin has been commonly placed in the bottom of the low-level reservoir, though convenience for attention is a good reason for placing this settling basin in the bottom of the high-level reservoir, as shown in Fig. 4 which is a diagram showing a flywheel oil lift and high-level settling basin.

The draincocks demand notice here, as it is the most likely thing that the ordinary designer will select a plain bib-cock as the readiest and lowest-cost drainage element, but the bib-cock is liable to accidental opening with unsuspected

loss of the entire oil supply contained in the splash pools and circulating systems. My experience includes two instances of this, caused in one case by running through a pile of soft sand, and in the other case by running over the branches of a small newly felled sapling; in each occurrence the bib-cock was opened, all the oil left the crank-box, a connecting-rod box melted out and the car had to be towed home. Fig. 5 shows a form of stop cock costing not one-tenth part so much as the cheapest bib-cock, and which never leaks and cannot readily be opened by accident. This device is original with me but has probably been used by others.

A hole is drilled into the screw end to meet the cross-holes. When the screw is turned home on the head flange it closes the hole tight. By turning the screw out of its seat far enough to expose the cross-hole free passage is obtained.

In the circulating oiling system the low-level oil tank capacity is the mileage factor of the oiling system and should either be in communication with the lubricating oil tank, or should be the receptacle of the hand-replenishment of lubricating oil, through a screw-closed, high-level filling tube, located at some place open to the hand and eye of the driver, so that he can see when the oil stands at the top of the filling tube.

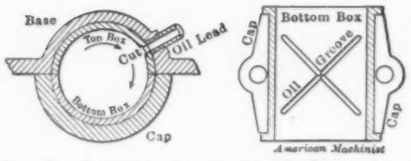


FIG. 6. CORRECT FORM AND LOCATION OF OIL GROOVE

FIG. 7. INCORRECT OIL GROOVES

ERRORS IN MOTOR OILING PRACTICE

Every machine journal should be enough smaller in diameter than its box or bearing to give room for a film of oil of measurable thickness, and if the bearing has a slack side, as is usually the case, oil should be supplied there to give free access of the oil to the revolving journal. If the lubrication is flooded there should be overflow cuts in the journal-box as shown in Fig. 6, which is a partial cross-section of a crank-shaft journal box and cap. The top half-box has a groove cut straight through it, both groove ends open; the oil-lead is shown as being tapped into the base to meet the oil hole drilled into the box groove correctly located at the point of most clearance in the box which is, in this example (vertical-cylinder crank shaft, running top to right) at the point where the oil lead enters the box.

In common practice both connecting-rod boxes and crank-shaft boxes are almost always scored as shown in Fig. 7, with crossed grooves for oil distribution and dirt catching, these grooves being closed at their outer ends so that they not only catch whatever dirt the lubricating oil may contain, but hold it, as the closed oil-groove ends prevent dirt discharge, and so enable the dirt to do its worst toward scratching and cutting the journal. The cuts are commonly crossed at the middle of the box, where they can most reduce the box resistance to wear and are altogether wrong in every way, serve no useful purpose whatever and are decidedly and materially harmful. Every mechanic well knows that when pulled apart the crossed-spiral blind oil grooves are always full of dirt and abraded metal particles, yet no mechanic ever fails to make these blind oil grooves in a split journal box if left to his own choice, and many routine designers are much surprised when the manifest faults of these standard crossed oil grooves are pointed out to them.

Outline of a Course in Machine Work

By E. H. Fish *

A table outlining operations representative of general machine work.

To be broadly trained there are several lines of work that could be included in the outline, but from the standpoint of cutting metal this outline seems sufficient.

*Manager, Worcester School of Trades.

Nearly every technical school in the country has a different machine-shop course from every other. In fact, there are about as many different conceptions of what a machinist should know and what an engineer should know as there are people trying to teach the trade or the profession.

Most of the college courses are like Topsy—they "just growed." Since this is the case, it seems as if a brief study of what constitutes machine work is in order.

Machine work is primarily the cutting of metal, with intelligence. Secondarily, it is the putting together of the work cut; and in the third place, it is the laying out and inventing the means for doing it. The last two cannot be done without intelligence, though there are degrees of that.

Our school shops deal almost exclusively with the cutting of metals, though their graduates deal more with the other two parts of the trade than with the first. This is proper if time is limited, for the practice of cutting metal is the basis on which the erection and design of work is done.

OUTLINE OF MACHINE WORK

The accompanying outline speaks for itself as a subdivision that I have used as being representative of general machine work. To be sure there are many things that a machinist should know that are not strictly machine work and are not included in this table, and there are many things which a machinist does in certain lines of work that are not general, and again there are undoubtedly omissions that should be filled. For example, a machinist is better off in some shops if he knows how buffing and polishing are done, brazing, peening, lacing belts, forging tools, hardening, tempering and so on. All these are valuable things for any machinist to know, but they are all parts of other trades and are therefore not included in the table.

If a boy is graduated from any technical school or trade school without having actually performed with his own hands nine-tenths of the things set down in this table he has not had the breadth of training that he needs for either the trade or the profession. If he is learning the machinist's trade, he should have done the work represented by this table with enough work on each item to make sure that he will do the work habitually well. On the other hand, if the boy is learning the trade, he can be trained almost entirely on a small part of these operations to advantage. For example, a boy may put in considerable time on a planer, strapping work to the table to stand heavy cuts, and he may do a considerable amount of boring work held in a chuck. If he had done these things he needs but very little time boring work held on the faceplate of a lathe, only enough to realize the necessity of balancing and to find out how to get work fast without stop pins. If he has had considerable work in the vise or a shaper, he needs less experience on work in a vise on the miller, and so on.

Beyond the mere cutting of metal, it is always a question as to how far either an engineering school or a trade school should go. The assembling of work is valuable to the engineer mainly as it indicates to him the desirability of so designing future machines as to make them easily put together. We all doubtless know of shops where money has been freely spent to reduce cost of individual pieces where the same money spent in changing designs to aid in erec-

tion would have produced greater results.

Work on Erecting Floor

To the machinist work on the erecting floor is valuable, even if he is specializing in the running of any one machine in that it makes him conversant with the allowable limits of error in his work. One of my friends worked hours on a certain shaft for a very fussy customer, only to be told that it would likely be all right as it only fitted into the surrounding air. If he had been familiar with the machine into which it went, he would have run a roughing cut over it and stopped.

Machine design is really a part of engineering, but designing of tools is and must in most cases be done by the men who are to build them. This branch of design requires little knowledge of the strength of materials except that which must be learned by experience. It does require the highest ability along strictly machine-shop lines. As an elementary part of this work, it may be suggested that it may be combined with the reading of blueprints by having each student pick out parts of a machine from the assembly drawing and tell what operations should be performed upon it and in what order. By this means he will soon, under proper guidance, get to the point where he can plan out work intelligently and be ready to design such special jigs and fixtures as may be necessary.

The entire work and equipment of the Technologic Branch of the U. S. Geological Survey has been transferred to the Bureau of Mines, recently established, and it is interesting to note that out of a total $500,000 appropriated for the bureau's use, about $300,000 is to be expended in the investigation of mine accidents and the remainder used for the analysis and testing of coals, lignites, ores and mineral-fuel substances.

Cylindrical Surfaces	Engine Lathe	Short work between centers	1
		Center rest work between centers	2
		Center rest work on one center	3
		Center rest work in chuck	4
		Follow rest work	5
		Mandrel work	6
		Face plate, tool in tool post	7
		Face plate, tool in boring bar	8
		Chuck work, tool in tool post	9
		Chuck work, tool in boring bar	10
		Eccentric work on centers	11
		Eccentric work on face plate or chuck	12
		Taper work under 1, 2, 3, 4, 6, 7, 9	13
		Thread cutting under 1, 2, 3, 4, 5, 6, 7, 9	14
		Thread cutting with die	15
	Turret Lathe	Chuck work, tool in tool post	9
		Chuck work, tool in boring bar	10
		Eccentric work on face plate or chuck	12
		Thread cutting with die	15
	Boring Mill	Chuck work, tool in tool post	9
		Chuck work, tool in boring bar	10
		Eccentric work on centers	11
		Eccentric work on face plate or chuck	12
	Hand Lathe	Short work between centers	1
		Face plate, tool in tool post	7
		Face plate, tool in boring bar	8
		Chuck work, tool in tool post	9
		Chuck work, tool in boring bar	10
		Eccentric work on face plate or chuck	12
		Taper work under 1, 2, 3, 4, 6, 7, 9	13
		Thread cutting with die	15
	Milling Machine and Gear Cutter	Horizontal milling, chuck or face plate	16
		Vertical milling, chuck or face plate	17
		Thread milling	18
		Spiral milling	19
		Spiral gear cutting	20
	Grinder, Universal and Plain	External grinding—short work	21
		External grinding, center rest	22
		External and internal grinding, chuck	23
	Hand work	Lapping	24
	Sensitive drill, Upright, Radial	Drilling, work free, to line	25
		Drilling, work strapped to table	26
		Drilling in jig	27
		Drilling, tapping and reaming	28
	Engine lathe, Turret, Hand	Drilling, flat drill, cored hole	29
		Drilling, 3 and 4-lip drill, cored hole	30
		Drilling, 2-lip drill from solid	31
	Hand lathe	Drilling between centers	32
	Hand Work	Scraping, boxes, etc.	33
	Horizontal boring machine or lathe	Work strapped to table	34
	Slotting Machine	Slotting in rotary chuck	35
	Planer and Shaper	Planing on centers	36
Plane Surfaces	Planer and Shaper	Flat planing	38
		Squaring down and cutting off	39
		Planing on angle (dovetail)	40
		Hooking under	41
		Work in magnetic chuck, 38, 39	42
		Work in jig, 38, 39, 40, 41	43
	Slotter	Slotting, plane surfaces	44
	Milling Machine, Horizontal and Vertical	Milling flat work	45
		Milling flat work, end mill	46
		Milling flat work, side mill	47
		Milling flat work, sawing	48
		Milling dovetails	49
		Milling tee slots	50
		Milling index work	51
	Engine Lathe	Face plate work	53
	Surface Grinder	Grinding, edge of wheel	55
		Grinding, face of wheel	56
		Work in magnetic chuck, 55, 56	57
	Hand Work	Chipping	59
		Filing	60
		Scraping to surface plate	61
		Scraping to originate surface plate	62
Irregular Surfaces	Milling	Milling with formed cutters	63
		Profiling	64
		Gear and rack cutting	65
		Hobbing worm gears	66
		Cam cutting	67
	Planing	Planing to templet	68
		Planing with form cutter	69
	Turning	Turning to templet	70
		Turning, formed cutter	71
		Turning by hand	72
	Hand Work	Chip, File, Scrape — Irregular surfaces	73, 74, 75

OUTLINE OF A COURSE IN MACHINE WORK.

Grinding Automobile Cylinders

By James N. Heald *

Problems which have arisen in the automobile industry and have been solved by the grinding machine.

Why boring and reaming do not produce true cylindrical surfaces. Finishing the inner surfaces of multiple cylinders. Cylinder grinding hot or cold? A word about abrasive wheels.

*General manager, the Heald Machine Company, Worcester, Mass.

One of the hard problems of automobile building is the production of accurately round and straight holes in engine cylinders.

Difficulty Due to Thin Walls

In boring gas-engine cylinders the walls are so thin that they will readily spring away from the boring tool, and a hard spot in the casting will dodge from under the tool and spring back again after the tool has passed on, leaving a high spot in the cylinder wall. (As indicated at *a* in Fig. 1.)

A soft spot will allow the tool to cut too freely and, if anything, cut below the correct depth, as indicated at *b*, leaving a depression in the walls, each condition being equally disadvantageous.

The high spot will act as a chafing point against rings and the depression will make a place for the gases to escape past the rings, and leakage means always a marked loss in the power developed by the engine.

If the cylinder has port holes in the side, the boring tool tends to jump into these openings, breaking off the corners, and for that reason it is more difficult to produce an accurately round and true surface at that point.

Reaming

It has been the practice frequently to follow this boring with a reaming operation, but this improves the hole but very little. If the blades of the reamer are long the walls will spring away just the same where there are hard spots, and the reamer accomplishes very little.

Shortening the blades of the reamer enables it to cut a little more freely than with long blades, but you do not get any assistance in regard to straightening the holes from the reamer with such short blades, and if the cylinder should happen to have a recess or port holes on one side, the reamer will invariably work off toward that side and the hole will not be straight. This makes trouble in fitting the rings.

Another great difficulty is in maintaining the size of the reamer.

Advantages of Grinding

The advantages of grinding are that the cylinder can be taken directly from the rough boring to the grinder and a surface quickly produced which is accurately round, straight and smooth. It has been made round because the grinding wheel revolves in a perfectly true circle and cuts away the hard spots as well as the softer material, the cutting particles being so sharp and the wheel so free cutting that the surface produced cannot help but be a true circle and the travel of the table being in a straight line, of course, develops the true circle into a true cylinder.

Occasionally some manufacturer will say that he does not believe in grinding because the rings do not seem to come to a bearing as quickly in a ground cylinder as they do in a bored cylinder and for that reason he thinks he prefers a bored cylinder. The answer is that the whole difficulty is usually in the manufacture or the fitting up of the rings. A ring properly made will not require much wearing away of the outer edge to come to a proper bearing in a ground cylinder.

Quite a number of builders are making the mistake of finishing a piston ring on the periphery by grinding, that is, making a beautiful smooth surface on the outside of the ring and then putting it into a bored cylinder, the effect of which is first of all to score and roughen up the surface they have just made so nice and smooth.

In the writer's opinion, if he could grind but one he would ten times rather grind the interior of the cylinder and produce a surface there which was round and straight and use a turned ring, than to bore the cylinder and fit to it a ring nicely ground on the exterior surface.

The ideal combination is, of course, ground cylinders and ground rings.

Action of the Grinder

In grinding cylinders to produce a perfect surface, the thin walls present no difficulty, because the grinding wheels cut the iron so freely that they do not bring any pressure on the walls of the cylinder to cause the metal to spring away and spring back again after the wheel has passed on.

The various speeds of rotation and feeds provided enable the operator to work to the best advantage at all times in regard to the character of surface produced so that round and straight holes with an excellent finish are always possible with very little effort.

Another problem has arisen, namely that of grinding multiple cylinders, that is, those in which there were two or more holes in one casting.

Special Grinders Designed

This problem has been solved by designing a machine in which the grinding wheel not only rotates on its axis but also travels in a circular path, while the cylinder is mounted on the table of the machine and travels parallel to the grinding spindle, rotation of the cylinder not then being required.

In order that the machine may grind holes of both large and small diameters and also to provide a feed of the wheel into the work when grinding a cylinder of any given size, it was necessary to arrange some device in this rotating head for producing such adjustment. This was effected by a combination of two eccentric sleeves, the one carrying the grinding spindle being mounted inside the other and larger eccentric. This construction allows the spindle to be so located that the eccentricity of one will offset the eccentricity of the other when the wheel is to travel in a very small circle and produce a small hole.

Changes of Speed

To secure the largest production and highest grade of work, the grinding head should be equipped with several speeds of rotation, and the work table should also have different rates of travel, so that during the roughing cuts the work can be fed one-half or three-quarters of the width of the wheel face, to obtain the most rapid cutting and removal of stock, and the fine feeds are used in the finishing cuts so that all feed marks on the work disappear and a mirror-like surface is obtained.

Speed of Grinding

The rapidity with which work can be turned out on the best types of these machines can be indicated by the finishing of holes 4 inches or 4½ inches diameter by 9 inches long directly from the rough boring in about fifteen minutes each, removing 0.010 inch in diameter, the hole being round and straight within a limit of 0.0005 inch or better.

For grinding cylinders with more than one hole it was, of course, then necessary to arrange a crosswise adjustment of the table of the grinder so that after finishing one hole the cylinder could be moved transversely exactly the right distance to the next hole, after which the grinding could be resumed and the second hole brought to the desired size. This was accomplished by the mounting of a cross slide table having a screw with micrometer readings and an indicator so that one hole after another could be brought to the correct position in the shortest possible time.

Transferring Multi-cylinder Castings

It will be readily understood that the transferring of the cylinder casting in this way insures that the holes shall be absolutely parallel in every case, and the distance between the holes can also be adjusted by use of the micrometer screw, with which this table is operated. So great is the accuracy of these machines that they will grind a hole actually round and straight within one-quarter or one-half thousandth of an inch.

Advantage of Accuracy

Now, this accuracy in the grinding of the hole means a great deal in fitting up piston rings and getting full power when starting up the engine.

The writer has been in a factory where boring and reaming have been used for finishing cylinders before the installation of a grinding machine, and has been told by the manager that after the grinder was installed they learned for the first time that they had never been getting straight holes, their cylinders having port holes on one side, and it had been proved to them that whereas their sizing plugs had apparently fitted the bored and reamed holes excellently, yet when the grinder was installed the grinding wheel took off and ground away material from that portion of the cylinder opposite the ports to a degree which showed them that the reamer had always dodged off toward the open side of the cylinder, in spite of every effort they had made to avoid it.

The writer has also been in a shop where the management felt that they were not getting the power they should when their engines were assembled, and after a grinding machine was installed and the finishing was done by grinding, these same people reported that they had increased the power of their engine from 15 to 20 per cent. at the start off. In other words, while the former engine with the bored and reamed holes might have worked itself into condition after a time to deliver its full power, the engine with the ground cylinder was in a position to deliver it immediately upon being put on the testing bench.

Lapping

There are some people who have not been converted to the merits of finishing by grinding and are lapping their cylinders to produce the surface desired. While this produces a smooth surface on the interior of the cylinder, yet it does not get rid of the errors in regard to the diameter and high and low spots entirely, it takes considerable time, and it also is liable (unless rightly handled) to enlarge the cylinder at a certain point, which is objectionable, and many cylinders are injured by lapping in the hands of careless workmen.

It has always been a problem to the writer to know what guarantee one has who is lapping cylinders that the lapping process will not continue after the engine is assembled and in service. If certain abrasive material is put into the cylinders for the purpose of lapping out the surface of the cylinder and rings, what means has the manufacturer of preventing the continued operation of this to a greater or less extent even after the engine is assembled and put to work?

Many people are afraid that the grinding machine is going to charge the interior of the cylinder with grit and wear

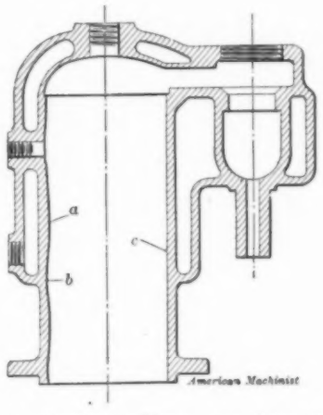


Fig. 1. Showing High and Low Spots in Bored and Reamed Cylinder

out the rings. To prove that there is absolutely no foundation for this fear, I would cite the use of the grinding machine for finishing spindles, shafts and the important parts of the very best machine tools manufactured, such as spindles for lathes and milling machines; in fact, it is actually true that the higher the grade of machine manufactured the more the grinding machine is used to fit up the respective parts.

No Emery in Finished Surface

It has, moreover, been proved by chemical analysis, using acid to eat away the surface which has been ground, and then analyzing same to see if there is any emery in it, that no trace of the cutting material can be found in this way.

Wet or Dry Grinding

The question of wet or dry grinding on these machines has been thoroughly tried out, and the general experience has been entirely in favor of grinding dry; that is, without water on the wheel or in the hole, where the grinding is being done.

While this is usually true with grinding cast iron in any form of an internal grinder, it is especially so with cylinder grinders in which the work does not rotate.

When water is used in the hole, a certain amount of muddy water collects and lies along the bottom of the cylinder, into which the grinding wheel dips at every revolution of the head, and the sediment and refuse in this water is picked up more or less by the wheel which tends to clog and fill up the wheel face, reducing its ability to cut the stock as rapidly as when grinding dry.

As the purpose of using water in any event would be to maintain a uniform temperature, we prefer to run the water into the jacket, and use the wheel dry, thus securing both the greatest output, and also the advantages of uniform temperatures.

The dust produced in dry grinding should be carried off by means of an exhaust fan, which is, of course, a very simple matter to arrange.

Grinding Hot or Cold

One other matter of interest comes up at this point in connection with grinding cylinders, namely, whether cylinders should be ground hot or cold, and on this point there is some division of opinion.

The great majority of those grinding cylinders are grinding them cold. This is due partly to the fact that it is easier and partly to the fact that it is then possible for the inspector to inspect the accuracy of the cylinders after they leave the grinding department, and before they are carried along further in the process.

There are those, however, who believe in grinding cylinders hot. The cylinders of the engines, of course, as soon as they are in service, are always hot when in operation, and for that reason it seems as though it might properly be argued that if the cylinder were ground with conditions similar to those under which it operates a gain would be made.

There is no question but what a cylinder in heating up changes its shape more or less.

Therefore, from a theoretical standpoint, if the water jacket is filled with hot water or steam when the grinding is being done, the cylinder will be to a certain extent approximately under the running conditions.

Trouble in Inspecting

From a practical standpoint, the writer is of the opinion that one of the principal objections to carrying this method out in the regular manufacture of the cylinders is the trouble occasioned when the inspector takes the cylinder in hand after the grinding. When the cylinder is on the machine and hot the hole may have been perfectly round and straight, but after the cylinder has been taken off and laid on the floor for an hour or more, and has cooled down to the original temperature, the inspector on going over it may find that it is not round.

If it had been ground cold it would not have changed in shape and it would be round when the inspector took it up. This is the main stumbling block in regard to grinding cylinders hot, which in theory

would appear to be a desirable method of handling the work.

The answer to the question whether to grind hot or cold should be found in a careful examination of the action of the cylinders under a change of temperature, and if the cylinder should be one that changes but slightly there would undoubtedly be too little gained by grinding hot to make it worth the extra trouble to carry out this method.

The advantages of maintaining a uniform temperature, to secure rapid production, however, are conceded by all, irrespective as to whether they favor the use of hot or cold water, and for that reason all machines should be fitted with pump and tank and supply pipes to enable the user to handle this in the best possible manner.

In Conclusion

It appears that better methods are required in finishing cylinders than those of simply boring and reaming; and that these requirements are fully and satisfactorily met by the processes of grinding.

Grinding is not an expensive operation, even though its advantages are so many, when you remember that it takes the place of smooth boring, reaming and lapping—three operations common to the old method of handling this work. Grinding is the most efficient method also, as there are no reamers to buy nor to keep sharp nor to continually readjust or regrind to maintain even approximately uniform diameters. Grinding will give you easily and cheaply parts that are absolutely interchangeable, which is so essential to high-grade work and so indispensable to low cost of production. In fact, the advantage of interchangeability alone would be sufficient to warrant the use of the grinding machine even if there were no other advantages to be gained.

The finish produced is superior to that obtained by any other process; multiple cylinders are handled as easily as single cylinders; better compression is obtained; full power is obtained at the start off; less trouble is had in regard to lubrication and better running engines can be produced than it is possible to build in any other way.

Points Affecting the Rate and Quality of Production

The speed of grinding cylinders depends upon a good many elements outside of the quickness of the operator.

One of these is the selection of wheels. This is a more important matter than three-quarters of the men operating grinding machines realize or understand. The characteristics of the iron used in different cylinders varies greatly, and a little variation in this makes quite a change in the grade and grit of the wheel often advisable.

To illustrate how great a diversity of wheels is required we might mention that we are carrying continually in stock about 25 or 30 different grades and grits in order that we may be able to select the most efficient cutting wheel for different grades of iron.

The operator cannot be too particular in regard to the grade and grit of the wheel, and if the output does not seem to be at any time what it should be, or if the surface produced is not satisfactory, he should at once look into the character of the wheel and try out some other combination to see if an improvement cannot be made in this respect.

The next point is the speed of the wheel. It is not only surprising but discouraging to the manufacturer of grinding machines to see how careless the majority of people are in regard to the speeds at which grinding wheels are run, and this is not limited to our machine by any means, but is true of plain grinders and even ordinary floor grinders for running a snagging wheel.

A great many people seem to lose sight of the fact that speed is a most important element in the proper operation of a grinding machine, because the cutting particles of a grinding wheel absolutely depend upon speed to give them their ability to cut, and a wheel which is properly graded to cut efficiently at a circumferential speed of 6000 feet per minute, will not cut efficiently and will appear to be decidedly off grade when running only 4000 to 5000 feet per minute.

In considering the output of a grinding machine, it must not be forgotten that this is not a "stock-removing tool," as some who are antagonistic to grinding seem to expect.

On the other hand, it is really a finishing tool, and is especially fitted for producing smoother and more accurately round, straight or flat surfaces than other machining processes are able to produce.

The grinding machine can remove in grinding a cylinder, five thousandths or fifty thousandths of an inch if desired, but if output is wanted, this latter amount is many times too large, and it will be better and quicker in every way to let the boring machine bring the hole to within about ten thousandths of the desired size, which it will do equally as well, and the smaller amount left for grinding will greatly increase the output per day.

When roughing out the stock it does not matter if the wheel surface becomes coarse and slightly roughed up as it will generally cut freer, but before taking the final finishing cuts the wheel should be trued off with a diamond—but a few thousandths of an inch usually being necessary to produce a surface—and the smoothness of the surface of the work will abundantly repay the moment's work required.

In grinding small work and small holes, the truing up of the wheel will not need to be done as frequently, and yet have the surfaces equal to all ordinary requirements.

The writer has taken the liberty of reprinting the following from "Facts Worth Knowing" with the permission of Norton Company:

Grinding Wheels

A grinding wheel is made up of two kinds of material, the grit or cutting material, and the bond. The cutting efficiency of the wheel depends largely upon the grit. The grade or hardness of the wheel depends largely upon the formula of the bonding material used to hold the particles together in the form of a wheel. The efficiency in grinding a certain metal is dependent largely upon the temper or the resistance to fracture and the character of fracture and the grit or cutting grains of the wheel.

Grinding wheels are made by three processes, vitrified, silicate and elastic. In making a vitrified wheel no pressing or tamping is employed. The cutting material and the bond are mixed in power mixing kettles, and the mixture is then drawn off into forming rings. The wheels are subjected to a high temperature, nearly 3000 degrees Fahrenheit, which causes the bond to fuse and vitrify. The personal factor does not enter into the making of this wheel.

Silicate wheels are made by the tamping process, special machinery being employed in mixing the bond with the cutting material. While in a plastic state it is tamped in iron molds. Wheels made by this process are especially adapted for tool and knife sharpening.

Elastic, or "shellac wheels," are bonded by gums such as rubber, shellac and resins. The mixture of the cutting material and the bond is heated, then pressed in molds. Great strength and elasticity are important factors. It is possible to make wheels by this process as thin as 1/16 inch. They are used chiefly for saw gumming, grinding between the teeth of gears, sharpening molding cutters and wood-working tools, cutting off small stock, and for roll grinding.

Grain and Grade

Grinding wheels are made in many combinations of coarseness and hardness.

Grain—The size or number of abrasive grain used, determines the wheel's degree of coarseness.

The abrasive grains are numbered according to the meshes per linear inch of the grading screen through which they have passed. The numbers usually used in grinding wheels range from 10 to 100.

Grade—Means the degree of hardness of the wheel, or resistance of the cutting particles under grinding pressure.

When the retentive properties of the bond are great, we call the wheel "hard;" when the grains are easily broken out we call the wheel "soft."

Wheels that are too hard, glaze; dressing resharpens them.

Selecting the Grade

The proper grade of wheel to use on any given job is dependent not only on the character of the work and the speeds used, but also very largely upon the stiffness of the machine, and the firmness with which both the wheel and the work are supported.

Intelligent mechanics too often entirely overlook the fact that a stiff and rigid machine allows the use of softer and freer cutting wheels than is possible in a lighter machine, which enables stock to be removed much more rapidly, and also without any chatter marks.

Therefore, in a way, the softness or hardness of a wheel is relative to the machine in which it is to be used, and therefore a wheel No. 46 grade "K" might be O.K. in a stiff and rigid machine, while it would be found to be entirely too soft in another make of grinder, even on identically the same work.

Preventing Accidents

By Frederick R. Hutton*

The three classes of injuries and the price which is paid by the individual, the employer and the community.

The payment prescribed by the New York law of 1910, the far reaching effect on the production of any plant and the cost of all accidents to the industry as a whole.

*Past president and honorary secretary of the American Society of Mechanical Engineers; chairman of the committee on Plan and Scope of American Museum of Safety, in New York.

In a previous article on page 179, the prevention of industrial accidents was reviewed from the point of view of the mechanical engineer as a designer of machines and of safety devices and appliances to protect the human factors of production. It is plainly to the advantage of the investor to have the machines used in production capable of continuous operation and earning power, and free from breakdowns. It is the aim of this section to develop and emphasize the economic loss to the owner and manager of an accident which injures the human factors of production.

When the industrial accident releases a force of great magnitude and it gets away from control, the human body of soft and fragile structure can only escape by getting out of the way. Where this is impossible, where the force acts too quickly, or other human units were in the way of escape, the frail body or its members undergo the mechanical injury inevitable under these circumstances. This injury is in one of three groups. It may be a minor injury, from which the victim recovers, but which for a time incapacitates him from wage-earning. It may be a major injury, destroying a member of the body by maiming it, so that the worker for the rest of his life is either incapacitated for productive industry altogether, or must limit himself to some very ill-paid function in the works. Or, in the extreme case the worker loses his life. An injury so slight that it does not keep a man from work and earning, scarcely comes under the discussion of an economic loss.

Now the price which is paid for an industrial accident to a wage-earner is chargeable to three accounts. Two of these are payable in legal tender, and are capable of valuation in dollars. The third is not so statable directly, and will be treated first and briefly.

It may be called the altruistic price. The accident must necessarily cause and be paid for in:

1. The physical pain of the sufferer and the anxiety and distress of mind, both of the victim and those identified with him at home.

2. The privation and wasteful expenditure in the home which is entailed by any disturbance of an economic balance; the cost of unusual or special foods, the surgical appliances and medicines; the withdrawal of interest-earning savings.

3. The loss of opportunity for the children of one whose wage-earning capacity is cut off. The youngsters must be made productive in whole or in part before their school education is completed, and the community and the individual is so much the poorer.

These considerations are purely altruistic to all others than the victims of the accident. To him they are very real and weighty, and to many they are urgent enough to call for action and study. They weigh outside of the industrial circle as well as within it. But within the industrial circle there are the other two sets of considerations which are selfish and direct in their appeal. What does it cost the owner and producer to have an accident which involves the incapacity of a trained and skilled workman? He pays for it both directly in the shop and indirectly in the community in which he lives. He pays directly in his plant in the form of:

1. The payment of the compulsory payment exacted by the law of 1910 in New York State. The limit of such exaction is set in the law at 1200 times the daily earnings of such a workman, and in no event at more than $3000 in the case of death or complete disablement. But in any case it is a cash loss, graded down from this superior limit in case of partial and short disablements. In other States, less advanced than New York, this cost appears in the insurance premium on the accident policies, and the cost of liability and indemnity insurance which the employers pay to protect themselves. The New York law may not eliminate liability insurance for a while if it ever does, since some very nice points of responsibility as respects coworkmen as employers will still leave openings for litigation.

2. The loss of this man's productive ability, if his place is kept for him. The plant as a whole earns so much the less while nearly all expenses run on unaffected.

3. The deterioration of the idle machine, the costs of the raw material which he is not rendering immediately salable, insurances, interest and the like, are running on without offset from the man's productivity.

4. The demoralization and lowered productivity of all the workers in the section or department where the accident occurred. Work stops completely while aid is being administered, and if the accident has distressing features (blood, agony, or disfigurement), the normal tone and standard will not be regained for a day, or perhaps for a week. This is a very real and costly loss.

5. The time to train and render skilled a new man to replace him who is permanently laid aside. Such labor as is spent by the foreman or gang-boss is taken from other productive employment on his part.

6. The less speed and lowered quality of the work of the new man until he gets his gait. To this should be added scrap losses, or from work imperfect and not passable by the inspectors.

The employer or owner pays indirectly for an industrial accident which transfers a producer to the purely consumer class in the community in the form of:

7. The contribution he makes to a mutual or benefit fund.

8. Or, in the contribution he makes directly or through local taxation or charity to the funds for poor relief.

9. The contribution he makes specifically or generally, or both, for the care of the injured in hospital, medical and surgical fees, nurses and ambulance service.

10. The litigation expenses or the settlement price, beside the expenses of

the conduct of the courts for his protection against inequitable suits which he pays in his taxes.

11. The tax which the dependents of the victim impose upon the community when the wage-earner is laid aside.

12. The old-age pension of the worker who has had to spend all his savings during the months of the acute stage of the injury and has not been able after the accident to renew his store. Another way of stating several of these items is that the community pays an old-age pension for many more years of non-productive life than should be required for the normal man.

We have not yet touched upon the obstacle to safety appliances which is met in practice from a psychological limitation inherent in nearly every one, which makes a man restless under any pressure to limit his working his own will, even if to do so would endanger his life and limb. But in conclusion, to give practical result to the analysis and argument which has preceded, may these considerations be urged:

1. That many accidents which now take place in most of the industries are largely preventable.

2. That as designers are awakened and educated to the possibilities of mechanical or physical devices for the prevention of accidents to the careless, the indifferent and the absent-minded, to this further extent will accidents be diminished.

3. That the duty of engineers, owners and managers is to enter upon and conduct a campaign of education by exhibition, by lecture, by inspection, and by precept that shall tend to increase the realization by the wage-earner that his life and earning capacity are an economic asset to the community, as well as a priceless treasure to himself.

4. That America, with its more active and restless civilization, because more progressive in many respects, is behind the older and more stable civilizations of Europe in providing museums of safety, where these and kindred problems may be effectively and easily studied by both the parties in interest; the labor union, working for the uplift and comfort of its members on the one hand; the employer who feels both his sense of obligation and the economic pressure of the productive problem on the other.

Helpless Buyer—Repairing Machines

By John R. Godfrey

It used to be the duty as well as the pride and pleasure of the mechanic to be able to handle any machine in the shop. But with the coming of the specialist, the operator of one type of machine, this was no longer necessary. And, due probably to a lack of knowledge of the foundation principles of the machines, the average operator feels timid about handling any machine but the one he is accustomed to.

Nor is this all. He is very apt to be content with running his machine without looking into its mechanism and is helpless when it breaks down. In some shops he is not allowed to touch it except to run it, no matter what happens.

This development may explain the apparent helplessness of many shops when anything goes wrong with a machine. Instead of carefully examining the machine to see what is wrong as might be expected, they too often write or telegraph the maker "that his old machine is on the bum again and if he ever expects any more orders, he better send a man who knows how and get busy on the job" or some such tactful greeting which always increases the high regard and friendly feeling of the maker for the user.

And, then, when the man who "knows how" has traveled several hundred miles and consumed numerous dollars worth of various hotel accommodations, he finds that a bearing has gone dry or is gummed, or that a nut has become wedged into a mess of gears.

Then the boss cusses the operator and squares himself by acknowledging that the joke is on him. But the expenses are on the builder and the owner of the machine would boil over with righteous indignation and enlarge on the niggardliness of some concerns, if he got a bill for the expenses actually incurred.

And if the builder insisted on collecting, the user would probably buy a rival machine next time, no matter if he knew it would cost him more to do his work. For he wouldn't be imposed on to the extent of paying for his own carelessness by any means.

But he quite overlooks the fact that he helps to pay for this because all such expenses must be distributed by the builder and go into the selling price of the machine. The unfair part is that the buyer who keeps his troubles to himself, and fixes his own machine helps pay the extra cost.

But it is not all dead loss, because he has the use of the machine in a much shorter time, and gets the corresponding profit from it.

Another Kind of a Buyer

All buyers are not that kind. Probably the majority are entirely different, as with my friend Lorton, who uses a number of planers. I would not dare call Lorton fussy—but he is particular with a capital P and he wants (and usually has) things pretty close to right.

His planers are of good makes, and yet his life has not been one grand sweet song, trying to get them to plane straight. Two of them have pretty long beds, one being made in two pieces.

Neither of these machines planed straight when they were first installed, although both are mounted on adjustable plates and carefully lined up. But Lorton knows how easily a long casting like a planer bed changes shape under strain. He also knows that you cannot ship a long bed of any kind a thousand miles on a flat car without subjecting it to more kinds and a greater number of strains than any of us dream about and so Lorton made allowances.

He filed and scraped the bed until it was straight and could do good work.

The other case was clearly an error in the building and was a bad example of lax inspection. The ways on the two parts of the bed did not line up within a sixteenth of an inch. The man who drilled the holes probably was not careful enough to keep the chips out of the V on one piece when setting his jigs and the holes did not match.

It meant a lot of work to rectify this mistake, but Lorton did the work and said nothing. I am inclined to believe I should have kicked in this last case—and not have called it unreasonable.

If the makers of these planers ever find out that a customer has spent good time and money in this way without a kick, they will have heart failure.

A newly developed machine for automatically making bottles, recently installed in a large glass works, is reported as giving excellent results.

A molten mass of glass is taken from the furnace on the end of an iron rod. Instead of "shaping" the glass on a flat surface and blowing through the rod, the first operator puts the molten glass into a straight cylindrical mold. A "neck shaper" is placed around the neck of the mold and a plunger shoved into the soft glass by a second man.

The blank, with the "neck shaper" still attached, is placed in a second mold of the size required for the bottle and compression, turned on by a third man, does the rest. As the impression made in the "blank" is the same size throughout, the pressure of the air is equally distributed and an absolutely uniform bottle is the result.

Making a Pattern for a Steam Turbine

By E. F. Lake

Pattern-construction methods employed in a large shop on steam turbines.

The layout, making and fitting nozzles, construction of core boxes, and practical applications of the universal wood worker.

While the making of wooden patterns for the shaping of metal parts is so old that it seems as if little that is new could be added to the current knowledge, still with the design of each new piece of apparatus different methods are required to get the most accurate, economical and satisfactory results. Consequently, it may be of interest to follow, in more or less detail, the pattern-construction methods employed in a large shop when making a steam-turbine pattern.

The pattern shown is that of a low-pressure steam turbine of the well known Parsons horizontal type, similar in design to the machines made famous by the Cunard turbine liners, "Mauretania" and "Lusitania." As the cylinder or barrel presents features of the greatest interest, that only will be considered; the making of patterns for the tail piece and spindle bearings offering little that is different from ordinary practice in making numerous other machinery parts.

In the securing of a good finished product it is, of course, essential to have a pattern that is satisfactory from every standpoint, and this can only be secured by the use, in the first instance, of the best lumber; pine of the grade known as clears is therefore used. It is kiln dried and planed on both sides, and then set on edge with air spaces on all sides, in brick-concrete storage rooms adjacent to the pattern shop. This brings the lumber to the patternmaker completely seasoned and fit to be used in making a turbine pattern.

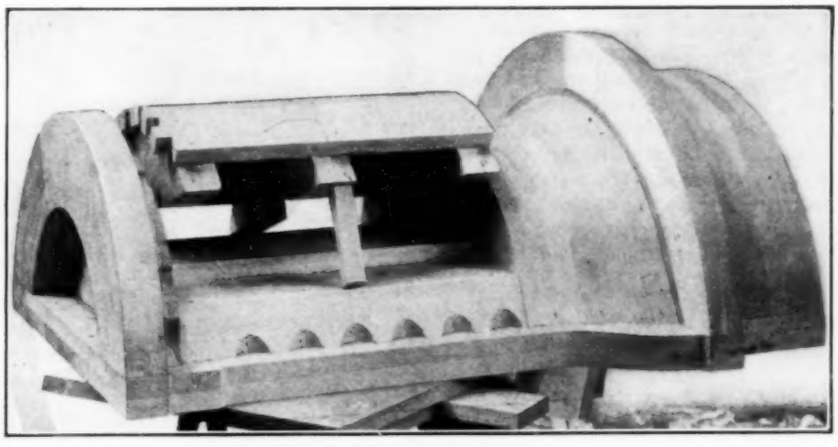


FIG. 1. UNCOMPLETED PATTERN OF ALLIS-CHALMERS COMPANY'S STEAM-TURBINE CYLINDER

LAYOUT FOR PATTERN

The drawing showing the finished dimensions of the turbine comes from the sales office, through the engineering department, with the order for the pattern. From this the various parts to be made are laid out in full-size section on boards. The layout is made with shrink rules, 1/12 inch to the foot being allowed on all dimensions over three feet and ⅛ inch on all dimensions under that. For finishing purposes allowances of ⅛, ¼ and ⅜ inch are made, depending on the location and character of the surface. During the construction of the pattern care is taken to leave space enough at various places to provide for the swelling of the wood which occurs when it is in contact with damp molding sand.

After the various layouts are completed they are assigned to different workmen so that each may complete his section. The parts in this case were: Body of turbine cylinders; two nozzles for cylinder; main core box for cylinder; and core boxes for nozzles, or nine parts in all. As the two halves of the turbine cylinder are exactly alike except for the nozzles, a pattern for one-half the body of the cylinder is made and detachable nozzle patterns are used on it. Throughout the pattern the most substantial construction is used. All the permanent parts are fastened together with glue and screws. The holes for all screws are bored with an electrically driven boring tool.

BASE AND TURNED PARTS

The base on which the half cylinder pattern is built, as shown in Fig. 1, forms the parting line. It is made of three 1¼x12-inch planks 4 feet long, with additional pieces secured around the edges to bring the whole to the proper thickness of the flange. These are held together by five cross pieces to which they are firmly glued and screwed. On the base thus formed the plan is drawn, the bolt holes laid out and the flange outline cut on the band saw. The circular parts of the pattern, as shown completed at each end, are then built up of segments sawed from 1¼-inch lumber and screwed and glued together. After the circular parts are placed, the thick pieces notched for nut clearances are fitted to each side, between the circular parts. These two pieces are fastened to the base and the space between them is covered by a board that serves to strengthen the pattern and act as a guide for the nozzles.

MAKING NOZZLES

On the main part of the pattern thus made are fitted the interchangeable nozzles; one being the admission nozzle and the other the valve nozzle. Both are fitted on to similar bases, one of which is shown in Fig. 1 with a block under one side. In making these bases three forms are made by gluing and screwing together 1¼-inch pieces and on these 1¼ staves are fastened. These pieces are built up in place and are then planed to conform to the required shape.

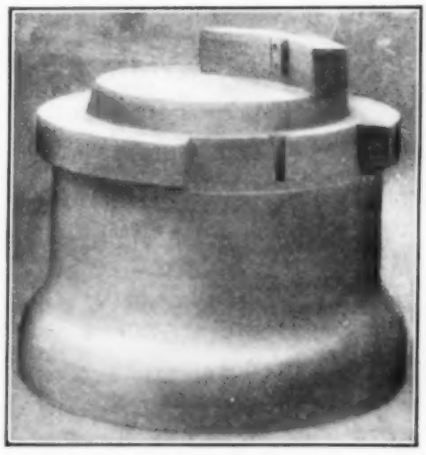


FIG. 2. STEAM NOZZLE SHOWING LOOSE FLANGE SEGMENTS

The valve nozzle, shown partially completed in Fig. 2, is built up of segments and turned in a lathe. The segments are 1¼ inches thick and 3½ inches wide. As shown, the flange is made in six segments and secured loosely to the main body of the nozzle, by dovetails. These dovetails hold the flange in position while the mold is being rammed, leave the

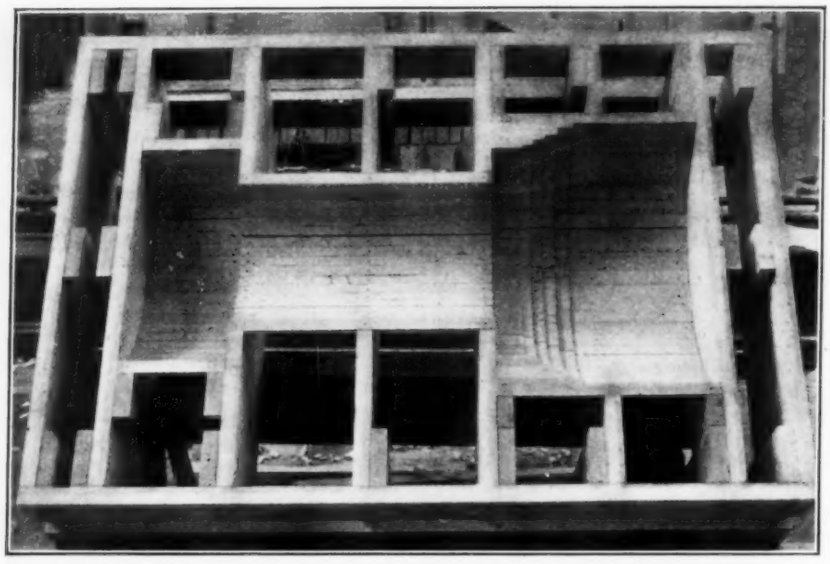


FIG. 3. PARTIALLY COMPLETED MAIN CORE BOX OF CYLINDER

flange segments in the sand when the pattern is drawn. One joint of the flange is made a miter joint instead of a radial, which permits the drawing in of that section, after which the rest are easily drawn. The nozzle, as turned, is then fitted to the base previously prepared.

The admission nozzle shown at *B*, Fig. 4, is quite different from the valve nozzle, but is built in much the same way. This nozzle is shorter than the other and has no flange. As shown, it is fitted with an auxiliary admission pipe for supplying live steam when necessary. On a base similar to the one used for the valve nozzle, are fitted the admission nozzle, auxiliary admission and special core print.

FITTING NOZZLES

After being completed to this point the nozzles are placed on the main body of the pattern and the supporting ribs are carefully fitted on and firmly fastened in place. All corners are then filled with leather fillets of ample radius. Core prints built up of 1¼x3½-inch segments are then fastened to each end of the main body of the pattern as shown.

In the bottom of the pattern are fastened iron draw plates with threaded holes that permit the insertion of a screw eye. By this means the pattern can be lifted by a crane, or, if necessary, by hand. The drawing plates are so located that when the pattern is lifted by the screw eyes it is in practically perfect balance.

In the bottom of the pattern are also fastened three iron plates with projecting pins on them. These pins hold the pattern in a fixed position on the match board and make all molds come in the same relative position; for the match board has sockets into which pins, on the cope of the flask, fit. The match board is shown supporting the pattern at *A*, Fig. 4. It is made extremely strong to withstand the shocks it gets in molding, and is protected by strips of boiler iron placed around the edges.

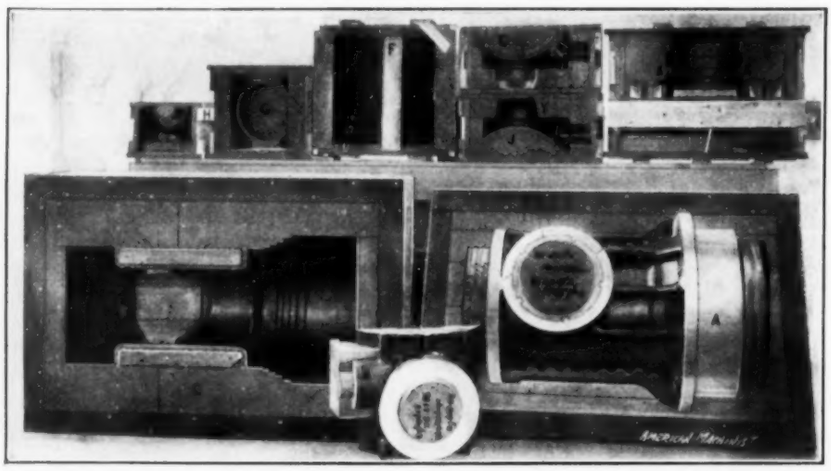


FIG. 4. COMPLETED PATTERN AND CORE BOXES OF TURBINE CYLINDER

MAIN CORE BOX

In Fig. 3, and at *C* in Fig. 4 is shown the main core box. A very strong, rigid method of construction is employed; so that there is no possibility of the box being racked out of shape. The supporting and bracing members are all of 2-inch material. Fig. 3 shows the method of construction very plainly.

The cross members are sawed to the requisite shape and supporting forms are put in where necessary. On these shapes 1⅛-inch staves are fastened and their inside make the box the proper radii after sandpapering. At the end where the stepped section is shown several layers of strips are used. These are cut to the correct form and one set fastened on top of the other.

The top of the box is then finished as shown at *C* in Fig. 4 and the core print for the nozzle core is placed. Around the outside edges of the top are placed pieces of boiler iron which protect the face of the box. Holes are placed in these which fit pins on the drag of the flask. The core is made in the drag on a jarring machine so that it can be fitted to the cope and make the complete half of a turbine cylinder.

NOZZLE CORES

At *D*, Fig. 4, is shown the core box for the valve nozzle. There is an annular section around the main barrel of the cylinder which permits the steam to flow from the admission nozzle to the valve nozzle. The core for this section is made in conjunction with the cores for the nozzles. This valve-nozzle core is made in halves and the same core box is used for each half. Interchangeable parts are provided so that either a right-hand or left-hand half can be made. Those parts which are marked *X* are the ones that can be changed.

Certain parts of this box have an irregular curved section that is worked out on the universal wood-working machine as shown in Fig. 5. This is one of the most useful and economical machines on the market for pattern-shop use. The details of its construction and operation were described and illustrated on page 769, Part 1, Volume 32, of the AMERICAN MACHINIST.

UNIVERSAL WOOD WORKER

This Wadkin universal wood worker can be driven directly by a motor fastened to the main shaft or through belting as in this case. A 5-horsepower, 1130-revolution per minute, 60-cycle, three-phase induction motor is mounted on the floor and is belted to the shaft of the machine. A potential starter for controlling the machine is mounted on the wall. Cone pulleys provide for speed variation.

The movements of the head and table will permit of the cutting tool being brought into practically any position relative to the work on the table. This,

coupled with auxiliary attachments to the table and a large assortment of cutting knives, permits of almost any sort of work being performed.

By means of a supplementary top for the table it is possible to cut true circular patterns. If the radius of the circle is greater than the clearance of the machine, when the table is set with its center directly under the spindle, the work can be done in segments and turned with the top of the table, which in this case would be moved laterally on its track. Work up to four-foot radius can thus be handled.

Extra Frames

For work of longer radius, wooden frames have been arranged, as shown in Fig. 6, which are supported at one end by the table and at the other by a horse. It has a movable slide carrying a staff which is in line with the cutting spindle and which serves as a center about which to revolve work.

This device can also be used for work which is too large to be carried by the table but which will clear the frame. Draft can be given the work by tilting the head to the desired angle. For the larger radii a tool is ground to the correct radius and its position changed at the end of each cut.

In this latter case a hole is drilled through the tool, which is put in the holder and a belt passed through to clamp the two sides of the holder tightly together. This makes the adjustment of the tool easy and also holds it in such a manner that there is no possibility of its flying off if it should come loose.

Small Cores

Referring again to Fig. 4 the core boxes, *E*, *F*, *G* and *H*, are all used in connection with the admission nozzle. *E* is the main box and is for the central core. The division is through the center line of the live-steam admission pipe. This brings it off the center line of the nozzle and in consequence the loose piece marked *Y* is provided. After this is removed the box can be removed from the core. The small parts, shown with the pins in, form the guides for the entering live steam when that is used.

The core formed in box *F* fits the circular section shown at *J* in box *E*. The core is very easily and quickly made by sweeping up with the sweep provided.

In box *G* is made a core which is pasted to core *F* and makes the opening to the annular chamber.

In box *H* is made the core for part of the live-steam admission pipe and its support. A separate core is made for this section because of the fact that if it were made a part of the main pattern there would be difficulty in ramming the sand properly around it, besides the further trouble of having numerous removable pieces to bother the molder.

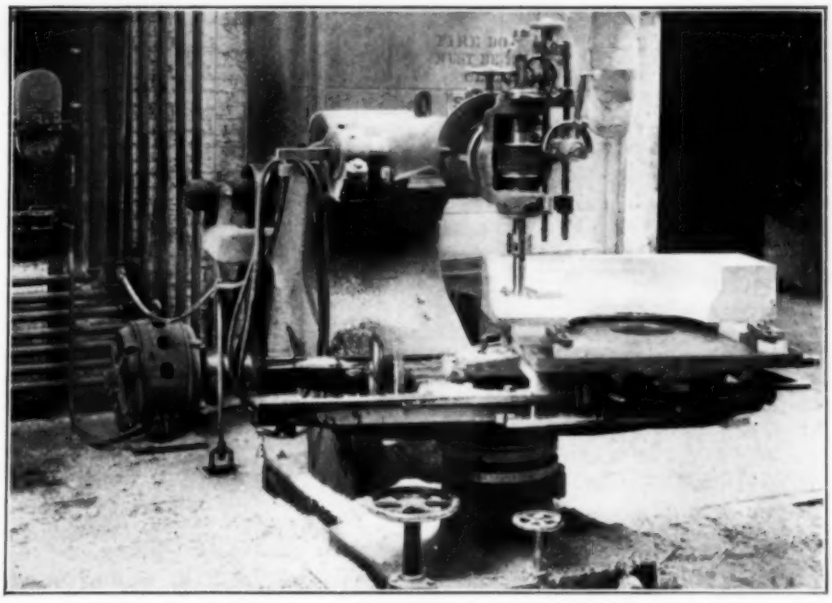


Fig. 5. Wadkin Wood Worker Shaping a Section of Core Box

Conclusions

These are the parts which must be made in wood before it is possible to secure a turbine cylinder. To indicate to the molder just what each surface is for, the different parts are shellacked different colors. Yellow is used for core prints, white for finished surface and black for rough iron.

After the workmen have completed the parts and they have been shellacked, the foreman carefully checks over all the measurements to see that the pattern has been correctly made and then has suitably numbered metal tags fastened on each piece. These tags serve to indicate the machine for which it is a pattern and where it should be stored.

The design of the pattern and the method of making it all assist in decreasing the cost of the output. The substitution of a half cylinder pattern with interchangeable nozzles in place of a complete pattern, makes the pattern cost much less and does not in any way impair the accuracy of the casting. In fact, it improves it. The cost is reduced to the extent involved by the amount of the material and labor required in making the other half of the pattern.

The same can be said of core box *D*. Only a half box is used, with the consequent saving over the first cost of a complete box, while the quality of the completed core is fully as good as a solid core. Removable parts and substitute pieces wherever advisable, reduce the cost of molding to a minimum, while the cost of the pattern is hardly increased at all.

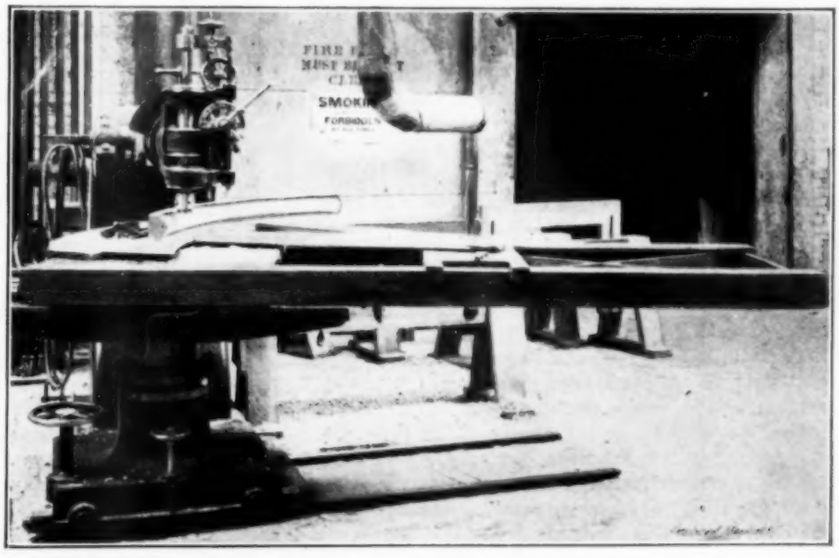


Fig. 6. Special Extension for Shaping Pieces of Large Radius. Finished Piece for Core Box in Position

Cost of Power, Heat and Light in Shops

By Sterling H. Bunnell *

An example, with figures, showing that in cold climates it is usually cheaper for the shop to generate its own power and heat with the exhaust steam, rather than purchase power from a public service company and heat the shop with a low-pressure boiler. In moderate climates and when water power is available, the conditions may be reversed, and in such cases the subject is worthy of study and calculation.

The increasing number of locations which offer cheap electric power from public-service corporations as an attraction to new industrial work, makes it necessary to consider carefully the real value of the power offered, in connection with the contingent services which must be otherwise supplied.

Electric power in the form of direct or alternating current, delivered at moderate voltage and at reasonable rates, presents an attractive proposition. Machinery can be operated by motors of familiar types, of moderate cost and with the possibility of variable speed; and small machines may be driven in groups from short line shafts. Electric transmission in itself comes very close to being superior in economy of power to shaft and belt transmission, so that it is usually found best, in constructing new shops, to provide engines with generators instead of belts and jackshafts, except where distances are short, power great and load constant. The problem may be therefore transferred at once to the power plant, and the comparison made between the cost of the transformed current at the factory switchboard, plus the cost of heat for the buildings, and the cost of steam power.

The economies of operation in large units make it obvious that the public service central station, being larger than any of the power plants which would be necessary for the factories which it supplies, ought to produce current at its switchboard at less cost than could be done by any of the smaller plants, and could, therefore, sell its current at rates which would eliminate such competition against the central station. There is only the cost of transmission and distribution, which generally will not be great enough to deprive the central plant of its advantage. The real obstacle which limits the field of the central station service is its waste of the heat in its exhaust steam. If, however, the current is generated by water power, and the cost of electricity is thereby limited to the repairs, interest and depreciation on the development, and the slight expense for attendance, the sale price of current may be so low that the proposition will be attractive under any conditions.

The deciding factor, in the case of all but the smallest shops, is the cost of heat. In a warm climate, or in a shop full of forges or ovens, extra heat may be unnecessary. In temperate and cold climates, the amount of heat required for the factory generally puts the public service out of the running. Central stations operating by steam are recognizing the cost of the waste in their exhaust, so that many of them are now equipped to furnish heat to buildings in their neighborhood, and even to a great distance, by

*Works manager, Griscom-Spencer Company, New York City.

exhausting their engines into a system of low-pressure heating mains.

The first step in making the comparison is to calculate the amount of heat required for the factory. The various constants for loss of heat through walls, roofs and windows of various constructions, are given in pocket-books and works on heating and ventilation. The total exposed surface of the building being calculated, the heat loss in British thermal units per hour, per degree difference in temperature inside and outside, is readily ascertained. The temperature difference varies with the hour, weather and season, but may be approximated by means of a table like the following, which was made for a city in the northern part of the United States, and for a factory in which the temperature desired was 60 degrees.

October	15 days, averaging 40° = 20° deficiency in temperature.
	15 days, averaging 50° = 10°
November	15 days, averaging 20° = 40°
	15 days, averaging 40° = 20°
December	10 days, averaging —5° = 65°
	10 days, averaging 5° = 55°
	10 days, averaging 15° = 45°
January	15 days, averaging —10° = 70°
	15 days, averaging 5° = 55°
February	10 days, averaging —10° = 70°
	10 days, averaging 0° = 60°
	10 days, averaging 20° = 40°
March	15 days, averaging 20° = 40°
	15 days, averaging 40° = 20°
April	15 days, averaging 40° = 20°
	15 days, averaging 50° = 10°

In the works for which this table was made, the calculated loss of heat through all outside surfaces of buildings was 103,000 British thermal units per degree difference in temperature per hour. The greatest difference shown by the table is 70 degrees; the corresponding heat loss is 7,210,000 British thermal units per hour. To supply this amount of heat would require a low-pressure heating boiler, if operated at 10 pounds pressure and receiving the returns at 180 degrees, of about 220 horsepower. Multiplying out the amounts of heat required, and the number of days for each, and allowing 12 hours per day, six days per week, and 50 per cent. extra for banking fires and maintaining some heat nights and Sundays, the amount of coal necessary, at an evaporation of 7½ pounds of water per pound of coal, is found to be about 1000 tons for the period of seven months during which heat is required. If power for this factory is obtained from an electric generating station at a distance, the cost of heating the buildings is estimated as follows:

ESTIMATE OF COST OF HEATING FOR SEVEN MONTHS

Value of 220-horsepower low-pressure boiler plant, without buildings, but including setting and some piping from boiler to starting point of heating system, approximately $2400.

Depreciation and repairs at 10 per cent. per annum	$240.00
Coal, 1000 tons at $3.00	3000.00
Labor at $2.25 per day, 210 days, including fireman's time cleaning boiler on Sunday	472.50
Coal passer and laborer at $1.50 per day, 210 half days	157.50
Supplies and incidentals	50.00
Total operating cost per annum	$3920.00

The power requirement of this plant for the operation of machinery is 150 horsepower throughout the year. The cost and operating expense of a steam plant to furnish 150 horsepower, with excess capacity sufficient to make up the deficiency in exhaust steam in the coldest periods, is estimated as follows:

COST OF FURNISHING 150 HORSEPOWER 12 MONTHS AND HEATING AS BEFORE.

Value of 220-horsepower boiler plant for 125 lb. pressure, otherwise same as before	$3500.00
Depreciation and repairs on boilers at 10 per cent	$350.00
Depreciation and repairs on engines estimated on 10 per cent. basis	300.00
Coal for 150-horsepower at 4 lb., 3120 hours, $3.00 per ton	2808.00
Engineer, 360 days at $4.00	1440.00
Fireman, 360 days at 11 hours at 22½c.	890.00
Labor coal passer and helper, 360 half days at $1.50	270.00
Cylinder oil, $100.00, engine oil $72.00	172.00
Packing, waste and supplies	100.00
	$6330.00

Exhaust steam from this plant at 30 pounds per horsepower per hour, containing 15 per cent. condensed water, would supply by the condensation of the remaining steam 3,422,000 British thermal units per hour, which is insufficient for heating whenever the difference in temperature inside and outside the factory is more than 33 degrees, or for 120 days.

The average heat required during working hours for 130 days at the estimated degrees difference in temperature per

hour is easily calculated to be 4,944,000 British thermal units.

The deficiency during the 120 days is, therefore, 1,502,000 British thermal units per hour, equivalent to about 1500 pounds steam or 200 pounds coal per hour, or a total of $200 \times 12 \times 120 \times 3 \div 2000 =$ $432.

And for heating nights and Sundays, say one-third the coal required for low pressure heating only.....	$1000.00
Brought forward.....	6330.00
Total cost of power and heat.....	$7762.00

As the power furnished to the factory amounts to 468,000 horsepower hours, the additional cost, as compared with the cost of furnishing heat only, is $7762—$3920 or $3842 amounting to 82/100 cents per horsepower hour. Obviously no central station service could hope to compete in price by furnishing power without heat to this factory in its cold climate. The calculation as given is not complete or exact, but greater accuracy could not alter the decision in this case. If the power required were much greater, or the heat requirements much less, it might be necessary to figure more closely the cost and operating expense of the power plant for the factory, and to consider the advantage of having less of an investment in the factory plant, and perhaps, a decrease in insurance rates, or the advantage of location in a place where fuel might be more expensive, but other things more favorable.

If steam in quantity were required, as for testing engines in manufacture, the *extra* expense of furnishing power for the factory would not include firemen's wages. If electric lighting is done by the factory's own power, the exhaust from these engines will help out the plant and decrease the quantity of coal burned for heating alone. In the case of lighting, the central station may furnish lamps and trim them without extra charge, which goes to decrease the factory expense and is a point in favor of the central station service.

In general, it may be concluded that large machine shops located in the northern row of States of the country will find it more economical to provide their own power. Shops located in the central belt may occasionally be served so cheaply by the public-service plant as to give the latter the advantage. Small shops in the northern districts, and large shops everywhere, can only determine the relative advantage by a careful calculation in each separate case.

Pneumatic Railroad Shop Tool

Editorial Correspondence

Device operated by compressed air for holding work to be drilled; for breaking out old staybolts; for rolling flat seams of boiler jackets, and for swaging and scarfing flues.

Fig. 1 shows one of the many uses made of the pneumatic work holder which is provided for every machine having need of it in the Beech Grove shops of the Big Four Railroad. Its most frequent application is in connection with radial-drill work, as can be seen in this instance. It consists primarily of the pneumatic cylinder *A*, which has a pipe from the air line running into its base. When air is admitted it forces the plunger *B* up against the clamping lever *C*. This clamping lever fulcrums in the yoke *D*, which is made to be easily fastened to any part of the table by T-headed bolts so that it can be applied in almost any position.

Another view of this work holder can be had in Fig. 2 and any shops having air-pipe connections will find it a great time saver as it entirely does away with the use of straps and bolts in any work of its kind. A small cock controlling the air supply makes it very easy for the operator to clamp the release work instantly, which will be found very convenient when setting for a particular location.

We recently saw a gear-tooth cutter which had cut 111 inches at the rate of 4 1/16-inch feeds per minute in 4-pitch gears. The gear blanks were 45-point carbon steel and the cutting speed 75 feet per minute. The cutter had not been ground during the work.

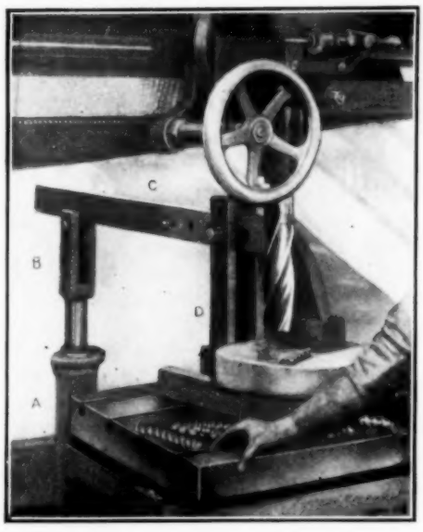


FIG. 1. PNEUMATIC CLAMP

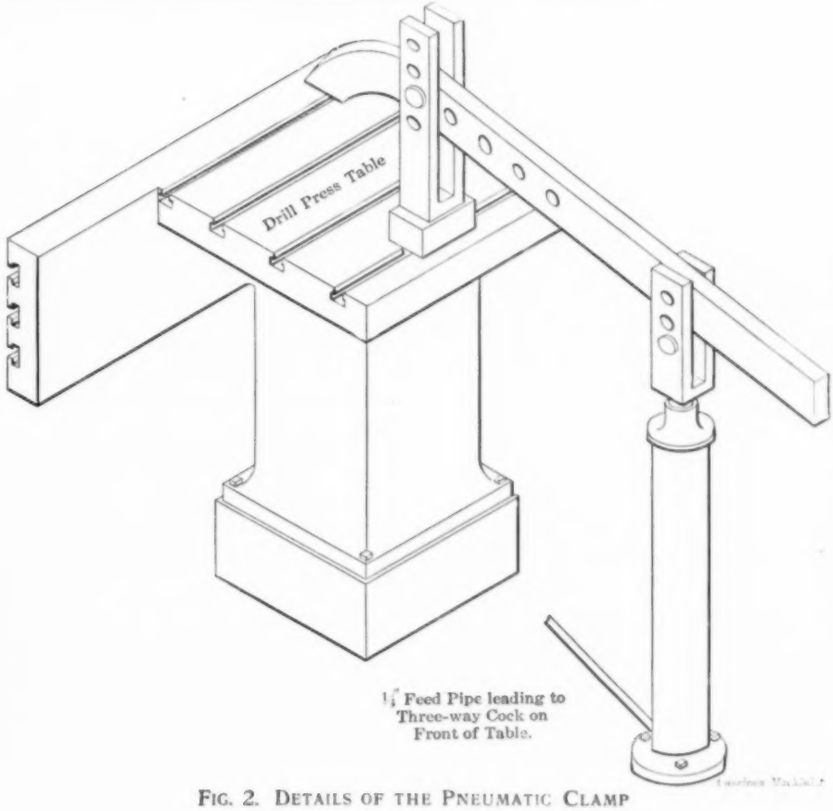


FIG. 2. DETAILS OF THE PNEUMATIC CLAMP

Chemical Standards for Iron Castings*

By John Jermain Porter

Cast iron treated as an alloy and the effect of the various ingredients present in the metal or used in making the required mixtures.

The physical properties of the metal and its behavior at different temperatures.

The classification of castings and the chemical composition of iron castings as used for various purposes with a suggestion as to the best mixture to use for numerous purposes to which iron castings are put.

*Condensed report of paper read as a report of the committee before the American Foundrymen's Association, at Detroit, Mich.

Cast iron is a complex alloy of six or more elements. The common elements are: Iron, carbon, silicon, sulphur, phosphorus, manganese; and the other elements sometimes present are: Copper, nickel, oxygen, nitrogen, aluminum, titanium and vanadium.

Iron occurs in three allotropic forms known as *alpha*, *beta*, and *gamma*, whose properties differ greatly. Absolutely pure iron is unsuitable for castings.

Carbon is the most important element in cast iron. It exists in many forms, all of which are included under the two heads of graphite and combined carbon.

There is still much doubt about the iron-carbon diagram. Upton's construction is the most recent and probably nearest the truth. This diagram holds only for very slow cooling, but gives us a consistent basis of reasoning.

The total carbon is dependent upon the temperature in the blast furnace, the conditions of melting and the percentage of other metalloids.

Graphite weakens iron. The amount depends upon the per cent. of total carbon, the rate of cooling, the per cent. of silicon, the per cent. of sulphur, and the per cent. of manganese. The normal graphite limits are shown by equations.

Combined carbon hardens iron and may increase or decrease the strength. The amount depends upon the per cent. silicon, the rate of cooling, the per cent. sulphur and the per cent. manganese.

The approximate effects of carbon are shown diagrammatically.

Silicon exists in cast iron in the form of silicides. Its chief effects are through its action on the carbon.

Increasing the silicon decreases the total carbon because it replaces carbon in the molten solution.

Increasing the silicon increases the graphite because it replaces carbon in the solid solution, the displaced carbon being precipitated as graphite.

Iron-carbon diagrams for commercial cast irons containing 1, 2 and 3 per cent. silicon are given and explained. The theory of malleableizing and of Custer's process is explained by these diagrams.

Impurities

Phosphorus exists in cast iron as the phosphide Fe_3P which is insoluble in the solid iron-carbon solution. It forms a ternary eutectic containing 2 per cent. carbon, 6.7 per cent. phosphorus, and 91.3 per cent. iron, which has a freezing point of 1740 degrees Fahrenheit. Phosphorus decreases the total carbon and the relationship is shown by a diagram.

The net effect of 1 per cent. phosphorus is to lower the temperature at which freezing begins 50 degrees Fahrenheit, lower the temperature at which freezing ends 425 degrees Fahrenheit, increase the temperature range of solidification from 50 degrees to 375 degrees Fahrenheit.

According to Upton, the effect of phosphorus on carbon is to slightly increase graphite and decrease total carbon.

Sulphur exists in cast iron as iron sulphide and manganese sulphide.

Iron sulphide forms a eutectic with iron melting at 1780 degrees Fahrenheit and insoluble in the solid iron-carbon solution. It therefore forms films between the iron crystals and causes brittleness.

Manganese sulphide does not form these films and is less detrimental. Manganese has a greater affinity than iron for sulphur and with enough manganese all the sulphur will be in combination with it.

Sulphur has a greater tendency to segregate than any other constituent of cast iron. This tendency is greatest with manganese sulphide.

Sulphur tends to decrease graphite and increase combined carbon. Upton's explanation of this is given.

The presence of silicon decreases the amount of sulphur which cast iron can take up. Much sulphur reduces the total carbon, and *vice versa*.

Other Metals Present

Manganese may exist in cast iron as manganese sulphide or as manganese carbide. According to Upton's theory, manganese carbide does not exist, but the manganese is in the form of a solid solution. This theory does not seem satisfactory.

Manganese has little effect on the melting point or composition of the iron-carbon eutectic. It strongly retards the *gamma* to *alpha* transformation and thus tends to harden iron.

Manganese can neutralize sulphur and will also remove dissolved oxide at high temperatures as in the blast furnace.

Traces of copper are common in pig iron. Its effects on cast iron are poorly understood. In steel, copper increases fluidity, hardness, and tensile strength, and decreases ductility and ease of forging. Cast iron will take up only about 5 per cent. copper and this does not affect the casting properties. Copper accentuates the red-shortness due to sulphur through the formation of the ternary Fe-Cu-S eutectic. Copper prevents a complete evolution of sulphur in iron analysis.

Small amounts of nickel occur in many pig irons. Its chief effect is to lower the *gamma-alpha* transformation temperature and to increase the graphite. Its effects on the strength and ductility of cast iron are relatively unimportant.

Gases and Purifiers

Oxygen probably exists in cast iron and causes lack of fluidity, weakness, brittleness, unsoundness, etc.

White iron is most liable to this trouble. The variable quality of different brands of iron may be due to more or less oxygen.

Deoxidizing agents, titanium, vanadium, aluminum, manganese and silicon may be used.

Little is known regarding the effects of nitrogen on cast iron. If present in any quantity it probably causes weakness and brittleness. It exists in iron as a nitride and can be removed by means of titanium.

Aluminum is sometimes added to cast iron. A few tenths per cent. causes finer grain, freedom from blowholes, decreases the tendency to chill, decreases the hardness, increases the strength, improves the elasticity. These effects are probably due to its deoxidizing power. Large amounts of aluminum decrease fluidity and increase combined carbon.

Titanium is used as a deoxidizer. It may be added to cast iron as *ferro-titanium* alloy in the cupola or in the ladle, or as titanium thermite in the ladle.

Doctor Moldenke's experiments show 52 per cent. increase in strength for gray iron and 18 per cent. increase for white iron, which has been treated with titanium. Only 0.05 per cent. titanium is necessary.

Titanium does not affect hardness or shrinkage of gray iron, but on white iron

	Silicon.	Sulphur.	Phos.	Mang.	Comb. Carb.	Total Carb.
Acid Resisting Castings:						
	1.00%	0.050%	0.50%			3.00%
	2.30	low	0.20	0.41%		3.60
	0.80–2.00	0.02–0.03	0.40–0.60	1.00–2.00		3.00–3.50
Sug.	1.00–2.00	und. 0.05	und. 0.40	1.00–1.50		3.00–3.50
Agricultural Machinery, Ordinary:						
	2.20–2.80%	und. 0.085%	und. 0.70%	und. 0.70%		
	2.65	0.050	0.81	0.70	0.15%	3.50%
	2.25	0.070	0.70	0.80	0.30	3.50
	2.10	0.068	0.73	0.45	0.47	3.42
	2.00	0.089	0.89	0.46	0.50	3.39
Sug.	2.00–2.50	0.06–0.08	0.60–0.80	0.60–0.80		
Agricultural Machinery, Very Thin:						
	2.90%	0.050%	0.85%	0.70%	0.10%	3.50%
	2.50	0.080	0.65	0.60	0.30	3.50
Sug.	2.25–2.75	0.06–0.08	0.70–0.90	0.50–0.70		
Air Cylinders:						
	1.20–1.50%	und. 0.09%	0.35–0.60%	0.50–0.80%		
	1.90	0.074	0.50	0.65		
	1.12	0.085	0.40	0.70	0.70%	3.50%
	0.95	0.100	0.30	0.90	0.80	3.40
	2.00	0.070	0.30	0.60	0.40	
Sug.	1.00–1.75	und. 0.09	0.30–0.50	0.70–0.90		3.00–3.30
Ammonia Cylinders:						
	1.20–1.90%	und. 0.095%	und. 0.70%	0.60–0.80%		
Sug.	100.–1.75	und. 0.09	0.30–0.50	0.70–0.90		3.00–3.30%
Annealing Boxes, Pots and Pans:						
	1.20%	0.060%	0.10%	0.40%		
	1.80	0.03	0.70	0.60		2.90%
	1.53	0.04	0.33	1.08	0.58	3.68
Sug.	1.40–1.60	und. 0.06	und. 0.20	0.60–1.00		low
Automobile Castings:						
	1.80%	0.030%	0.50%	0.70%	0.60%	3.50%
	1.65	0.076	0.45	0.65	0.55	
	2.35	0.72	0.60	0.70	0.40	
Sug.	1.75–2.25	und. 0.08	0.40–0.50	0.60–0.80		
Automobile Cylinders:						
	1.65%	0.076%	0.45%	0.65%	0.55%	
	2.31	0.094	0.50	0.43	0.51	3.35%
	2.70	0.053	0.46	0.23	0.44	3.02
	2.45	0.102	0.72	0.41	0.41	3.47
	2.59	0.083	0.57	0.47	0.11	3.35
	2.55	0.104	0.82	0.32	0.09	3.04
	2.98	0.047	0.89	0.27	0.14	3.19
	2.67	0.111	0.73	0.38	0.10	3.24
	2.30	0.084	0.81	0.52	0.59	3.35
	1.60	0.083	0.54	0.42	0.66	3.75
	3.26	0.159	0.93	0.44	0.03	2.87
	1.72	0.091	0.58	0.48	0.62	2.52
	1.67	0.068	0.44	0.82	0.62	3.91
	1.38	0.093	0.62	0.52	0.76	3.61
	1.47	0.075	0.13	0.60		
	1.50	0.103	0.86	0.43		
	1.99	0.130	0.65	0.39	0.45	3.17
	1.89	0.090	0.70	0.39	0.77	3.34
	2.29	0.090	0.83	0.60	0.90	4.16
Sug.	1.75–2.00	und. 0.08	0.40–0.50	0.60–0.80	0.55–0.65	3.00–3.25
Automobile Fly Wheels:						
	2.35%	0.072%	0.60%	0.70%	0.40%	
	3.10	0.045	0.35	0.55	0.27	
Sug.	2.25–2.50	und. 0.07	0.40–0.50	0.50–0.70		
Balls for Ball Mills:						
	1.00%	0.100%	0.30%	0.50%		low
Sug.	1.00–1.25	und. 0.08	und. 0.20	0.60–1.00		low
Bed Plates:						
	2.20%	0.090%	0.55%	0.50%		
	1.32	0.090	0.40	0.60		
	1.65		0.28	0.92	0.72%	
	1.85	0.080	0.60	0.55	0.50	3.25–3.50%
	1.80–2.20	0.04–0.06	0.45–0.55	0.40–0.50	0.40–0.50	3.40–3.60
	1.65–1.85	0.070	0.65–0.80	0.60–0.75		3.85
Sug.	1.25–1.75	und. 0.10	0.30–0.50	0.60–0.80		
Boiler Castings:						
	2.50%	und. 0.07%	und. 0.20%	0.80–1.0%		
	2.25	0.060	0.62	0.59		
Sug.	2.00–2.50	und. 0.06	und. 0.20	0.60–1.0		
Brake Shoes:						
	1.50%			low		low
	2.00–2.50	und. 0.15%	und. 0.70%	und. 0.70%		
	2.00–2.50	und. 0.15	und. 0.70	und. 0.70		
	1.40–1.80	0.06–0.08	0.50–0.80	0.45–0.60	0.40–0.65%	3.50%
	1.86	0.183	1.93	0.33	1.22	3.01
Sug.	1.40–1.60	0.08–0.10	0.30	0.50–0.70		low
Car Castings, Gray Iron. *See also Brake Shoes and Car Wheels:*						
	2.20–2.80%	und. 0.085%	und. 0.70%	und. 0.70%		
	1.40–1.80	0.06–0.08	0.50–0.80	0.45–0.60	0.40–0.65%	3.50%
	2.25	0.050	0.60	0.75		3.50
	1.75	0.070	0.85	0.60		
Sug.	1.50–2.25	und. 0.08	0.40–0.60	0.60–0.80		

	Silicon.	Sulphur.	Phos.	Mang.	Comb. Carb.	Total Carb.
Car Wheels, Chilled:						
	0.50–	0.05–	0.35–	0.30–	0.50–	3.50%
	0.70%	0.07%	0.45%	0.50%	0.75%	
	0.58–0.68	0.05–0.08	0.25–0.45	0.15–0.27	0.63–1.0	
	0.73	0.080	0.44	0.44	1.25	4.31
	0.86	0.127	0.35	0.49	0.92	3.47
	0.70	0.08	0.50	0.40	0.60	3.50
	0.58	0.141	0.38	0.48	0.90	3.63
	0.57	0.101	0.41	0.42		
	0.68	0.188	0.36	0.53		
	0.67	0.170	0.38	0.81	0.74	3.66
	0.50–0.60	0.08–0.10	0.30–0.40	0.45–0.55	0.70–0.80	3.50
Sug.	0.60–0.70	0.08–0.10	0.30–0.40	0.50–0.60	0.60–0.80	3.50–3.70
Car Wheels, Unchilled. *See Wheels.*						
Chilled Castings:						
	0.80–1.00%	0.09–0.11%	0.50%	0.50%		
	1.20–1.40		low			low
	1.00	0.08	0.40	0.75		3.25%
	1.35	0.117	0.60	0.54	0.65%	3.00
	0.50	0.200	0.45	1.50	3.00	3.00
	1.20	0.090	0.30	0.50	1.20	3.20
	1.20	0.080	0.30	1.25		3.50
	0.75	0.090	0.30	0.30	3.00	3.20
Sug.	0.75–1.25	0.08–1.0	0.20–0.40	0.80–1.2		
Chills:						
	2.07%	0.073%	0.31%	0.48%	0.23%	2.64%
Sug.	1.75–2.25	und. 0.07	0.20–0.40	0.60–1.0		
Collars and Couplings for Shafting:						
	1.60%	0.040%	0.55%	0.55%	0.30%	3.57%
Sug.	1.75–2.00	und. 0.08	0.40–0.50	0.60–0.80		
Cotton Machinery. *See also Machinery Castings:*						
	2.20–2.30%	und. 0.09%	0.70%	0.60%	0.45%	3.45%
Sug.	2.00–2.25	und. 0.08	0.60–0.80	0.60–0.80		
Crusher Jaws:						
	0.80–1.00%	0.09–0.11%	0.50%	0.50%		
	1.09	0.080	0.40	0.75		3.25%
	0.50	0.20	0.45	1.50	3.00%	3.00
Sug.	0.80–1.00	0.08–0.10	0.20–0.40	0.80–1.2		
Cutting Tools, Chilled Cast Iron:						
	1.35%	0.117%	0.60%	0.54%	0.65%	3.00%
ug.	1.00–1.25	und. 0.08	0.20–0.40	0.60–0.80		
Dies for Drop Hammers:						
	1.40%	0.060%	0.10%	0.40%		
	1.40	0.090	0.40	0.70	1.00%	3.20%
Sug.	1.25–1.50	und. 0.07	und. 0.20	0.60–0.80		low
Diamond Polishing Wheels:						
	2.70%	0.063%	0.30%	0.44%	1.60%	2.97%
Dynamo and Motor Frames, Bases and Spiders, Large:						
	1.95%	0.042%	0.40%	0.39%	0.59%	3.82%
	1.90	0.08	0.47	0.60	0.64	3.79
	2.15	0.070	0.75	0.60	0.55	3.80
	2.10	0.070	0.55	0.40		3.50
Sug.	2.00–2.50	und. 0.08	0.50–0.80	0.30–0.40	0.20–0.30	low
Dynamo and Motor Frames, Bases and Spiders, Small:						
	3.19%	0.075%	0.89%	0.35%	0.06%	2.95%
	2.30	0.070	0.55	0.40		3.50
	2.50	0.070	0.75	0.60	0.55	3.95
Sug.	2.50–3.00	und. 0.08	0.50–0.80	0.30–0.40	0.20–0.30	low
Electrical Castings:						
	3.19%	0.075%	0.89%	0.35%	0.06%	2.95%
	1.95	0.042	0.40	0.39	0.59	3.82
	1.90	0.080	0.47	0.60	0.64	3.79
	2.15	0.070	0.75	0.60	0.55	3.80
	2.50	0.070	0.75	0.60	0.55	3.95
	2.10	0.070	0.55	0.40		3.50
	2.30	0.070	0.55	0.40		3.50
Sug.	2.00–3.00	und. 0.08	0.50–0.80	0.30–0.40	0.20–0.30	low
Eccentric Straps. *See Locomotive Castings and Machinery Castings.*						
Engine Frames. *See also Machinery Castings:*						
	2.25%	0.080%	0.55%	0.60%		
	1.60	0.090	0.50	0.60		
	1.32	0.100	0.40	0.60		
Sug.	1.25–2.00	und. 0.09	0.30–0.50	0.60–1.0		
Farm Implements:						
	2.00%	0.089%	0.89%	0.46%	0.50%	3.39%
	2.10	0.068	0.68	0.45	0.47	3.32
Sug.	2.00–2.50	0.06–0.08	0.50–0.80	0.60–0.80		
Fire Pots:						
	2.50%	und. 0.07%	und. 0.20%	0.80–1.0%		
Sug.	2.00–2.50	und. 0.06	und. 0.20	0.60–1.0		low
Flywheels. *See also Automobile Flywheels and Machinery Castings:*						
	2.20%	0.090%	0.55%	0.50%		
	1.50	0.090	0.50	0.60		
Sug.	1.50–2.25	und. 0.08	0.40–0.60	0.50–0.70		

lessens the depth of chill and makes the remaining chill much harder.

Vanadium may be added to cast iron as a *ferro-vanadium* alloy. Doctor Moldenke's experiments indicate that small amounts greatly increase the strength of cast iron, especially of white iron. It is also thought to increase the resistance to shock.

Properties of Cast Iron

The strength of cast iron is dependent upon nine factors: 1, per cent. of graphite; 2, size of graphite flakes; 3, per cent. of combined carbon; 4, size of primary crystals of solid solution, Fe-C-Si; 5, amount of dissolved oxide; 6, per cent. of phosphorus; 7, per cent. of sulphur; 8, per cent. of silicon; 9, per cent. of manganese.

The best method of reducing graphite is to reduce total carbon by the use of low-carbon pig iron, by melting in the air furnace, or by the use of steel scrap in the cupola mixture. The chief difficulties in making semi-steel are, trouble with blowholes, high shrinkage, imperfect mixture of steel and iron, and absorption of carbon in the cupola.

The size of graphite flakes accounts for many cases of difference in strength of irons of the same composition. The factors influencing the size are very poorly understood. Among them may be rate of cooling, pouring temperature, time which iron has remained in the molten state, presence of dissolved oxide, presence of steel scrap in the mixture, mixture of different brands, nature of ore from which iron is made, and treatment in the blast furnace, per cent. metalloids.

From analogy with steel combined carbon probably increases the strength of cast iron up to about 9 per cent.; beyond that, decreasing it again.

Size of primary crystals of solid solution Fe-C-Si should, by analogy with steel, be important. This is uncertain.

The effect of dissolved oxide is probably important. To reduce oxide we may get the best brands of pig iron, avoid oxidizing conditions in the cupola, and use deoxidizing agents.

Phosphorus lessens strength, particularly resistance to shock. One per cent. produces a marked effect.

Sulphur may indirectly strengthen iron through decreasing the graphite, but is more likely to weaken it through causing blowholes and high shrinkage.

Silicon and manganese act chiefly indirectly. Silicon should be kept as low as possible and still have the necessary softness. Manganese should be high, but if too high produces weakness.

Practical rules for making strong castings and a table of analysis of strong irons are given.

Toughness and Hardness

Of the elastic properties only toughness and elasticity are important in cast iron. The sum of these properties is given by the deflection. The factors influencing them are about the same as those influencing strength. Practical rules for obtaining the maximum toughness and elasticity and a table of very tough irons are given.

Maximum rigidity with the least sacrifice of strength and toughness is obtained through the use of manganese and combined carbon.

Hardness is due both to combined carbon and *gamma* solid solution. The latter explains the cases of hard cast iron which are yet low in combined carbon.

Phosphorus has only a slight hardening effect. Manganese may soften iron through its action on the sulphur, but in larger amounts will harden it. Sulphur is an energetic hardening agent. Silicon softens iron due to its action in decreasing combined carbon up to a certain point. Beyond this point it hardens, due to its direct action. The relationship between hardness and silicon is shown by a diagram.

Combined carbon is the chief hardening agent in cast iron. *Gamma* solid solution is formed by rapid cooling from above 1300 degrees Fahrenheit and may cause hardness in some cases.

In chilled iron the factors influencing the depth and quality of the chill are, pouring temperature, and percentage of silicon, sulphur, phosphorus and total carbon.

The higher the pouring temperature the deeper the chill. A table showing the relation between the per cent. silicon and the depth of chill is given. Sulphur causes a brittle chill and is undesirable. Phosphorus injures the strength of chill and causes a sharp line between the white and gray portions. Manganese increases the hardness of the chill and its resistance to heat strains.

The grain structure and porosity depend on the size and percentage of the graphite. Practical rules for getting close grained, dense iron are given.

Shrinkage

The term shrinkage includes contraction of the fluid mass or "shrinkage" and contraction of the solid mass or "contraction."

The mechanism of fluid contraction is not well understood. It is less the greater the amount of graphite. The tendency to form shrink holes bears little relation to chemical composition, but varies in different brands of iron. A means in testing this tendency is described.

Shrinkage curves showing the manner in which the solid mass contracts are given. The first expansion is due to the separation of graphite. The second expansion is due to the solidification of the phosphide eutectic. The third expansion is probably due to the change of the iron from the *alpha* to *gamma* form.

Rules of obtaining minimum shrinkage are given.

Fusibility, Fluidity and Expansion

The fusibility of cast iron depends primarily on combined carbon, and to a less extent on the phosphorus. Graphite affects the melting point only in so far as it dissolves in the iron at temperatures below the melting point. A diagram and table are given showing the experimental results of Doctor Moldenke.

Fluidity is determined by per cent. silicon, per cent. phosphorus, freedom from dissolved oxide and temperature above the freezing point. Practical rules for obtaining fluid iron are given.

The factors affecting resistance to heat are, per cent. phosphorus, sulphur and combined carbon and the density or closeness of grain.

Cast iron undergoes a permanent expansion on repeated heatings. It may increase as much as 46 per cent. by volume. The strength is decreased proportionately. A minimum temperature of 1200 degrees Fahrenheit is necessary. The growth is favored by the pressure of graphite and silicon. This growth is probably connected with the change from the *alpha* to the *gamma* state, taking place at about 1300 degrees.

A summary of published statements regarding the proper composition for castings exposed to high temperatures is given.

Behavior of cast iron at low temperatures is unimportant and is only mentioned.

Of the electrical properties of cast iron, permeability only is of importance. Some typical permeability curves are shown. The effects of the various elements on permeability are shown diagrammatically. Practical rules for obtaining high-permeability iron are given.

The factors influencing the resistance of cast iron to corrosion are poorly understood. A summary of published information along this line is given. Practical rules for obtaining castings resistant to corrosion are given.

Two classes of castings subject to wear are typified by a grinding roll and a brake shoe. Practical rules are given for obtaining resistance to wear.

There are no data as to the relation between the composition of cast iron and its coefficient of friction.

Blowholes may be caused by oxidized metal or by excess of sulphur. Dirty castings may be due to high sulphur, kish or segregated graphite, or oxidized metal. Porosity is usually caused by kish. Pinholes are often due to excessive sulphur. Segregation is the greatest in the case of high-phosphorus and high-sulphur iron.

White spots in the interior of castings are usually due to the iron boiling in the bottom of the cupola. Shrinkage strains may be aggravated by high sul-

phur. High phosphorus improves the surface or skin of castings and high manganese will cause the sand to peel readily.

Chemical Standards for Iron Castings

Regarding the classification of castings, it is evidently impossible to consider as separate cases all the different patterns. Nor would this be desirable, since any foundry must itself class its castings into comparatively few groups which are each poured from one kind of iron. For example, a shop doing machine-tool work may make castings from several hundred patterns and will use not to exceed four mixtures of iron for all of these, probably dividing the work into light, medium and heavy castings, with possibly a special mixture for pulleys. It is thought, therefore, that a classification according to use or properties necessary is in the majority of cases desirable.

Thickness is, of course, taken into consideration, since this largely determines the percentage of silicon necessary, and it has been the aim to subdivide the various classes according to section wherever possible. In this respect the writer has endeavored to follow the definitions of the American Society for Testing Materials, who have grouped castings according to thickness as follows:

"Castings having any section less than one-half of an inch thick shall be known as light castings."

"Castings in which no section is less than 2 inches thick shall be known as heavy castings."

"Medium castings are those not included in the above definitions."

The last analysis under each head is preceded by the work "Sug." (abbreviated from suggested) and is the tentative standard or probable best analysis *suggested* by your committee. It should be clearly understood in this connection that while this is based on careful study of both theory and practice, it represents only the individual opinion of the writer and is not necessarily infallible. Under is abreviated by "und."

Furthermore, these suggestions are incomplete in certain other respects. The most desirable percentage of silicon, for example, will depend largely on the exact thickness of the casting and the practice followed in shaking out. These factors, being in many cases undetermined, have been allowed for by giving fairly wide limits to this element. Again, the possibilities in the use of purifying alloys have not been taken into account here, although they have been discussed in the preceding parts, and the use of steel scrap has been ignored except that the "low" total carbon specified in some cases must, as a rule, be obtained in this way. Finally, in many cases a very wide range of composition is permissible and compatible with the best results.

The compositions for various purposes are given in the accompanying table, arranged alphabetically, and will be completed in the next two issues.

Utility of Patent Publicity

By Irving D. Kimball

Some pointers to inventors on securing information as to prior state of the art by securing "file wrapper and contents" from Patent Office or outside firms.

It often happens that a man sees a patent number and date on a machine. He is perhaps desirous of using something as near to the device marked as the patent will permit, and so sends to the patent office for a copy.

Now, if he wishes, he can go still further than this and send for a history of the case during the time the application was in the patent office. This is called a "file wrapper and contents" and will give the original specification and claims and every action by the office and response by the applicant.

From this he can see just what references and arguments were made against the application and by getting copies of the references will have a fair idea of the state of the art in that particular case. This is not always complete as the office may not have cited all the references that it had, nor some which were broader and would be infringed by the patent in question.

If he wishes to see who the present owner of the patent is, he can also send for a copy of the "title." Assignments of patents are supposed to be filed with the commissioner for recording within three months of their execution, and it is from these records that the title is searched.

These "files and contents" can be obtained from the commissioner of patents at a charge of ten cents a hundred words and the "title" of a patent at the rate of one dollar for the certificate and the search, if for an hour or less, and fifty cents for each additional hour. They can also be obtained from typewriter firms in Washington, and if haste is a requisite, this is the best way. For instance, a history is wanted at once. Unless one has an account in the office, he is unable to telegraph his order, and even if he has money on deposit there, if a large number of orders are on file, he may have to wait several days. Through an outside typewriter, in emergency cases, a file can often be mailed the same day the order is received. The writer has found some of these firms in Washington very efficient in this work.

It is sometimes advisable to inquire for an approximate cost, before ordering a copy of a file wrapper and contents. Two or three substitute specifications may have been filed and one or two hundred claims. The usual cost is but a few dollars, but it might be $20 or more, in a long, hard fought case.

The public at large cannot always afford to send for copies of the files, and it would seem that no injustice would be done if the office should publish the references cited in an application. This could be easily done in the heading of the patent specification by saying: "The following patents were cited as references in the application for this patent . . . . ." stating the names, numbers and dates of the patents and the country in which they were patented.

This would not be giving any more information than is now available, as the files of all issued patents can be examined at the patent office. But it would give such information to the poor man, as well as to the rich man or the corporation.

It also would seem as though the interests of the public would be served if the office were compelled to call the applicant's attention to every pertinent reference, instead of to the two or three strongest ones. In searching the files it would not be difficult for the examiner to also make a note of any patents which are likely to cover the applicant's invention.

This would not mean that the office should undertake to enter into controversy with the applicant, as to whether a patent is broader than his application or not, but that the office should simply call the applicant's attention to any patents which it would be to his advantage to know and which he should know, in order to intelligently handle his invention. This additional publicity would be of value to the public when it became open to inspection upon the issuance of the patent and would be of considerable service in many cases.

Every good chemical analysis may not indicate a good bar of steel, but every poor analysis shows up a bad one.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Testing Locomotive Pop Valves

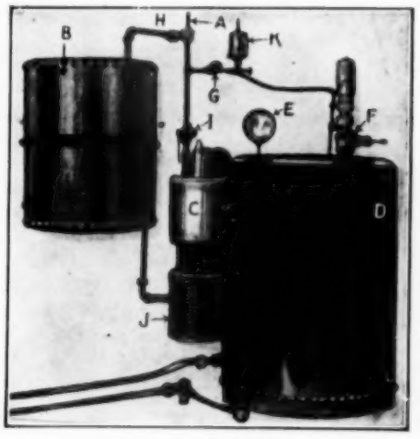
The halftone illustrates a plant designed for testing and setting locomotive pops by air at the desired pressure. It will be found that there is but a very small variation between a pop set with air and one set with steam at the same pressure, and by using air the workman is better able to make the adjustments before the pop is applied to the locomotive.

This plant comprises a main air pipe *A*, which in our case carries 100 pounds air pressure; an auxiliary air drum *B*, a 9½-inch Westinghouse air pump *C J*, with the air end bushed to 7 inches, and an air drum *D*, into which high-pressure air is delivered by cylinder *J*. Drum *D* is equipped with a pressure gage *E*, and a valve *F* where pops may be attached; also drain cock at bottom of drum. The air pump is bolted to the side of the drum, as shown in halftone.

To operate, open valve *G* and fill drum *D* with air at 100 pounds pressure. Close valve *G* and open valve *H*, which fills auxiliary drum *B* at the same pressure; then open throttle *I*, which starts air pump *C J* and pumps air from drum *B* into drum *D*, increasing the pressure in the latter as high as 225 pounds per square inch.

It would be impossible to get such a pressure if drum *B* were not used, as the action of the air from drum *B* piped into the inlet of air cylinder *J*, gives the pump more working power, by helping cylinder *C*.

The air pump is oiled by lubricator *K*, which is an old steam lubricator turned upside down, and acts as a drop feed instead of a float-feed lubricator. It works on all occasions without the least trouble.



LOCOMOTIVE POP-TESTING OUTFIT

This plant was built at the C. C. C. & St. L. R. R. shops, at Urbana, Ill., under direction of A. F. Bradford, general foreman.

Urbana, Ill. E. J. BUCKBEE.

An Australian Backing-off Attachment

The sketches illustrate a lathe backing-off attachment which I saw when visiting a Sydney works some months ago.

A, Figs. 1 and 2, is an ordinary face plate mounted on the spindle end. Engaging in two opposite slots are pins *B B* which rotate crank-pin plate *C*, thus imparting the desired oscillation to spindle *D* through rods *E E* and crank *F*. Slide bar *G* controlling the movement of the lower ends of rods *E E*, slides in bracket *H* secured to ribs inside the lathe bed. Spindle *D* is mounted in bracket *J*, which is clamped to the lathe bed, and which carries at its outer end a chuck. The enlarged end of spindle *D* is provided with a slot across its face into which is fitted the driving plate *K* enabling cutter mandrel *L* to be set to the requisite degree of eccentricity. Sleeve *M* engages with the slot in the spindle end to avoid possibility of rotating the cutter mandrel when the chuck is operated.

Each tooth of the cutter is backed off separately. The dividing is done by loosening the chuck and rotating the cutter mandrel, the correct location of the teeth being determined by a hight gage from the lathe body, the spindle *D* being in the same angular position when dividing for each tooth. This allows for a minimum space between cutter teeth, as adjustment can be made so that the front edge of the adjacent tooth can be run up close to the backing-off tool.

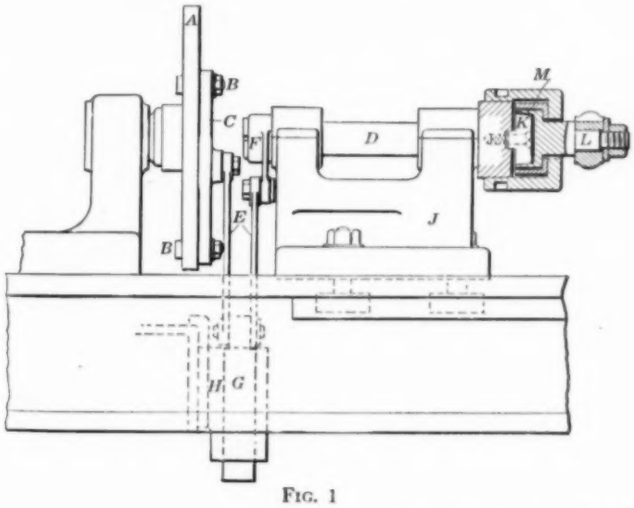


FIG. 1

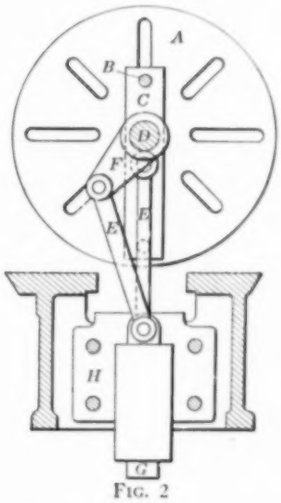


FIG. 2

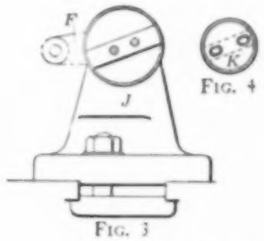


FIG. 4

FIG. 3

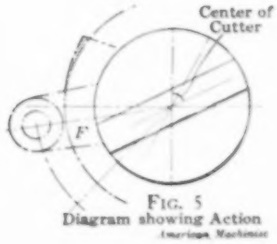


FIG. 5
Diagram showing Action

AN AUSTRALIAN BACKING OFF ATTACHMENT

This attachment involves no unshipping of the tool-slide screw; it can be entirely removed by unscrewing the face plate and unclamping the bracket *J*. It leaves the tool slide independent, avoiding to and fro motion, and it permits of easy adjustment of angular movement for various numbers of teeth to be backed off, and of eccentricity to suit the backing off required.

Fig. 1 is the front view of the complete attachment, the chuck being shown in section. Fig. 2 is an end view showing the arangement of face plate, crank plate and rods for oscillating spindle *D*. Fig. 3 is an end view of driving plate *K* showing the projection for the slot in the spindle and the slotted holes for the clamping screws. Fig. 5 is a diagram showing the action of the device.

Manly, N. S. W. JOSEPH JEWSBURY.

Sharpening a Drawing Pen

Sharpening a drawing pen is not a task eagerly sought by the average draftsman. In fact, the pen is generally allowed to fall into a serious state of decrepitude before, from sheer necessity, it is handed for repair either to an instrument maker or to someone who, by practice, has become expert in sharpening them. The usual method is to bring the blades together and round off, on a whetstone, the worn points to the desired contour. The nibs are then of the same length and shape. By careful manipulation of a moderately coarse stone, the points are ground from the outside, only, to a sharp edge and finished off in the same manner with a hard, smooth stone.

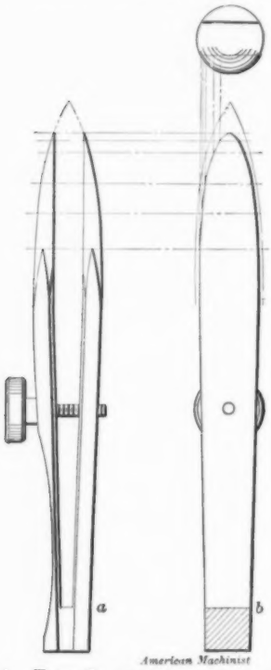


FIG. 1. THE SURFACES OF THE DRAWING PEN

While it is perfectly possible to satisfactorily sharpen a pen by this means, which is the one recommended by at least one prominent manufacturer, unless in skilful hands, the outer surface of the pen is more likely to consist of a number of small facets, than of a continuous contour, and, further, it is not an easy matter to secure a uniformly sharp edge without somewhat marring the previously rounded point. It may be particularly mentioned that on no account should the flat interior surface of the blade ever be touched with the stone.

On careful examination it will be noticed that the two blades consist approximately of a double curved surface of revolution intersected by planes, producing the shape of point shown in Fig. 1 (*a*). It follows that if the pen is suitably clamped and the whetstone be guided tangent to the curved outer surface of the blade, the contour at *b* will result from the intersection of the new surface and the inner surface, as the material is ground away. Such an apparatus might be well worth building if something equally good and costing next to nothing were not available. The substitute is a narrow strip of carborundum cloth and a clamp to hold the pen. The only other tool required is an ordinary magnifying glass.

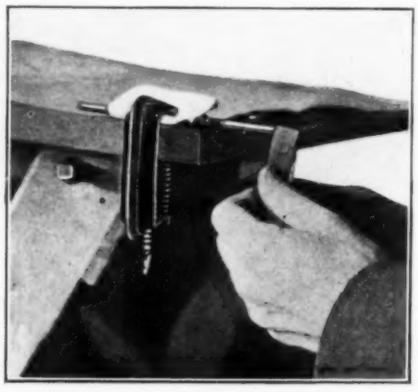


FIG. 2. SHARPENING DRAWING PEN WITH CARBORUNDUM CLOTH

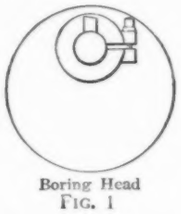
Fig. 2 shows better than any verbal description the method of working. The blades need not be initially rounded and ground to the same length. The grinding away of the material produces the correct point, something like a narrow ellipse, and the blades may be brought to equal length by the obvious method of giving the longer one a further grinding. Even with very little practice, the results are surprisingly excellent, and might easily be mistaken for the work of an instrument maker. It may be suggested that the excessively sharp edge is objectionable, but that is a fault equally applicable to the whetstone process and one quickly corrected by a few strokes on a piece of worn carborundum cloth.

LUCIEN E. PICOLET.

Philadelphia, Penn.

A Special Boring Job on the Lathe

Some little time ago our shop ran across a job of boring out a number of cast-iron columns of different diameters, but all of the same length. The interesting part of the job was that the columns were much too long for our biggest lathe, putting any boring-bar or steady-rest method out of the question. So I made a cast-iron plate as shown in Figs. 1 and 2, finished it on the back and one edge, and put a short bar in the boss which we provided with a binder screw, as may be seen. A piece of square self-hardening steel for a cutter completed the "special tools."



Boring Head
FIG. 1

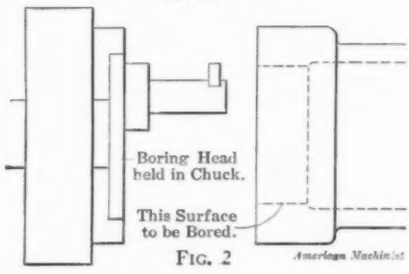


FIG. 2

SPECIAL BORING JOB ON THE LATHE

This boring plate was placed in the independent chuck. This gave an easy and close method of adjustment for the varying diameters. As to the castings themselves, they were clamped to blocks on the carriage.

When completed, we had a very fair job of work done with very little money tied up in fixtures that might or might not ever be of use again.

SILAS F. CRONK.

Middletown, N. Y.

The Section Liner for Lettering

As a mining engineer who occasionally uses drafting tools, I take the privilege of offering a suggestion in regard to the use of the section liner. In doing some block lettering lately, I happened on to the fact that this instrument is excellent for lettering. None of the boys here had ever heard of this use for that instrument, and so it may be a new idea.

In any class of lettering, except fancy

free-hand work, the section liner is set so that the space between lines will be one-fifth of the hight of a 4x5 letter, and then when used against a straight-edge the liner will take care of all spacing, giving a high class of work in less time than it takes to do a poor job after the usual method. In titles or other work of that type, by counting to the center and then working in both directions, a good spacing is obtained with the greatest ease.

Of course this will be of value only in lettering of sufficient importance to justify penciling before it is finally inked.

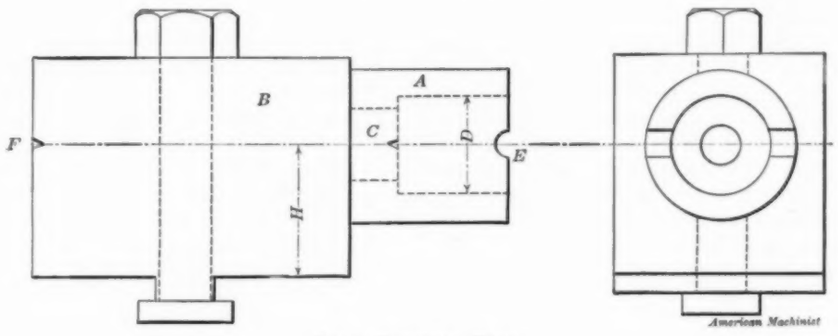
B. BRYAN.

Buenos Aires, South America.

A Ball Turning Tool

The accompanying sketch shows a very efficient tool for turning balls, such as are used in ball-and-socket joints, in which case it is permissible to have a hole through them.

The body of the tool, *B*, is best made of machine steel. The block should first be planed up to suitable proportions for the lathe on which it is to be used and the size of work to be done. Next, centers are drilled at a distance *H* above the base, equal to the hight of the lathe centers above the top of the tool rest, plus a small amount for finishing the base on the milling-machine centers. The end *C* is then turned on these centers.



BALL TURNING TOOL

The cylindrical part of the tool *A* is, of course, made of tool steel. It is bored to a force fit for hub *C*. This piece is then bored to the diameter of the ball desired, minus an allowance for grinding. After cutting the groove *E* for the arbor the piece is hardened and placed on *C*. With center *F* on the live center of the grinder and steady rest at *A*, the diameter *D* is ground to the exact size of ball desired, and the end ground either square or given a slight rake.

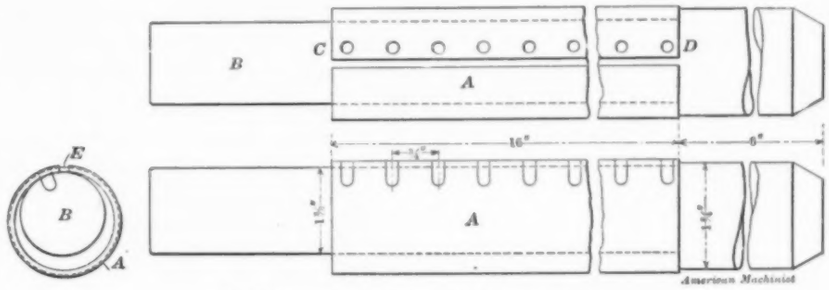
The balls should be roughed first with a turning tool and then this tool is fed over them. The tool gives the work an excellent finish, especially when the cutting edge is nicely oilstoned.

Saltville, Va. W. C. DIXON.

A Babbitting Arbor for Long Boxes

The sketch shows a babbitting arbor which has proved very useful. Solid arbors for long boxes are, as a rule, unsatisfactory. I have tried all kinds of covering with the same result. A long taper on boxes above 12 inches works best, but adds to the time required for reaming on account of the extra stock to be removed at the small end.

The new arbor consists of a piece of common pipe *A*, 4 to 6 inches longer than the hole to be babbitted, and ground to proper size. A false arbor *B*, the diameter of which is considerably smaller than the bore of the pipe, is placed inside of the pipe and riveted along the line *C D*. A saw cut *E* ⅛ inch wide is made through the pipe close to the rivets, allowing the pipe to close under the pressure of the shrinking babbitt. The enlarged end *F* of the inner arbor is eccentric with the arbor body but concentric with the pipe and slightly smaller. This shoulder butts up against the end of the pipe, so that when driving out the strain will not come on the rivets.



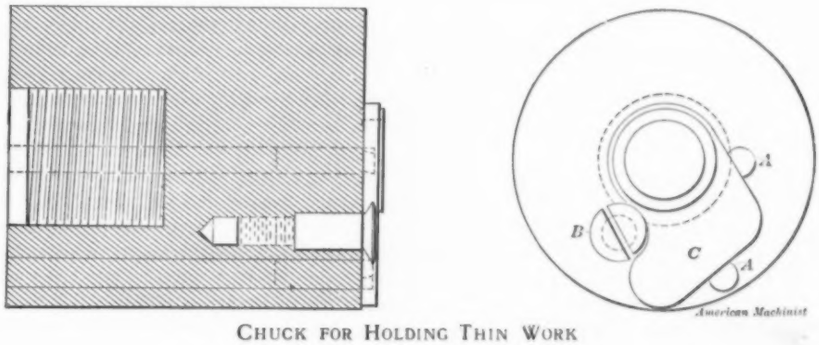
A BABBITTING ARBOR FOR LONG BOXES

In babbitting, the saw cut *E* is fitted with putty as this will readily be forced out when the babbitt shrinks and the pipe closes up slightly. It will be seen that in forcing out this arbor there is nothing more to overcome than the spring of the pipe due to the shrinkage of the babbitt.

Boston, Mass. T. R. TOWNE.

Chuck for Holding Thin Work

The chuck shown in the accompanying illustration was made to hold thin brass stampings while boring, threading and facing operations were performed. They formed parts of an optical instrument and a considerable degree of accuracy was required. As the different parts were not thicker than 1/16 to ⅛ inch, they were not stiff enough to be chucked in false jaws without risk of distortion. These chucks held them perfectly. The sharp edge of the cam-headed screw *B* got a bite in the edge of the stamping *C* and forced it against the steel pins *A A*, at the same time drawing the work hard against the face of the chuck. The holes in which the pins are driven were drilled right through the chuck to facilitate removal in case of breakage.



CHUCK FOR HOLDING THIN WORK

Birmingham, Eng. B. O. STONE.

Discussion of Previous Question

Tools for Screw Threading Metal Caps

Would any of your readers be kind enough to give sketches and particulars of the tools required for screw-threading metal caps, such as are used on metal-polish, etc., tins? As these have to be turned out complete at a very low cost, it would be interesting to know of a quick method for producing the caps.

Uplands, Wales. SCREW-CAP.

Value and Effect of Education

I have followed Entropy's frequent contributions to the AMERICAN MACHINIST, and it was with interest that I read his views on the Value and Effect of Education. However, I must say that I do not agree with him. After having observed and studied for some years, the methods and effects of technical training and education in general, I have drawn entirely different conclusions.

Does the public school so affect the child that the power of the parent over it is reduced? The first thing that a child learns instinctively is that he easily forgets details, and he is not surprised if his parent cannot tell him the hight of Mt. Hood or Mt. Blanc. The real loss of respect and control is due to the improper home training of the child, and the public school has little, if any, bearing on the case.

Men differ radically in their conceptions of what an education means, what it is for, and in what it consists. All school work, especially that prior to the college course, ought to be a training of the mind. To narrow the educational course of a boy while he is still young and growing, is wrong, and it will never make out of him a great man. He ought to learn to use his brain. He must learn to see into things; to look beyond the surface. In the grammar school the boy should be taught to do correctly and accurately those things which make easy his intercourse with his fellows. He must not only learn to write a decent letter, but he must learn to write the best that is in him. Genius will show itself if he has any; but even then he should be led along the beaten track until he is assured that he knows the field well enough to cross. The discouragement of individual thinking in the lower grades is an aid, and not a bar to clear thinking. Though the boy be the greatest genius that ever lived, he will never write a passable business letter until he has read and imitated the letters of others.

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

The matter of women teachers for boys is an important consideration. I still favor them for grammar-school work, even if they do tend to make the boy effeminate, as we are told by our English friends. But when a boy has reached the age of 14, it is time that he is put under the guidance of men. Every high-school principal realizes this, but he knows too, that he cannot obtain male teachers for the small amount he is permitted to pay them.

The next difficulty in a boy's education begins with the high school. It is there that he gets into athletics, and there that he learns to spend money. What should the boy include in the high-school course? If he intends to be a mechanical engineer, he takes up mathematics and a manual-training course. But he should not confine himself to these. He must remember that he will have to deal with lawyers, tradesmen, and men in all other branches, and that he will have to converse with women who will think him barbarously ignorant if he cannot discuss with them Balzac, or the literature of the day. The boy studies Latin, not that he will ever read or write it in after life. No, but the strict rules and memory tests train his brain to follow out a continuous course. Incidentally, by the study of a foreign tongue he learns to appreciate his own mother tongue, and make better use of it, and he gains an insight into the history and customs of another people.

I spent seven years in the shop and at the drafting board, before entering college. When I had finally determined to go, I chose a college where the mechanical course not only comprised mechanical subjects, but gave what they termed a liberal education. Three years of Latin, English history, etc., were demanded as entrance requirements. As I had to acquire them at night, after the day in the shop, I know what it is to work and study.

I do not favor working one's way through college if it means working during the college year. Perhaps some men have made good that way, but I have never seen any of them. If a boy has not the money to put himself through, he ought to work until such a time as he can see his way clear. He can do some preparing in the meantime. Opportunities are on every side. Every town has a good night school. Every college has scholarships that the average boy can obtain by a little hard work. Even the correspondence schools are good if used rightly. I completed a mechanical-drawing course in one of the well known correspondence schools in the spare evenings of one year, and was placed by them in a position where within a year I was able to double the pay I had received in the shop.

The man who does not have time for recreation and idle thought, is of little value, and never will be much good. I know one man who worked his way through college and is at present employed on a hand-screw machine. He is but one of a hundred similar cases which I may cite. I honestly cannot point out one man who worked his way through college and who now has a position that he could not fill without his education. The man who works all the time cannot develop his faculties. During two months of freshman year I spent in outside work an average of twenty-four hours a week. Now when I look back, I regret nothing more than I do those hours. That time I consider as wasted, whereas the hours I later spent on the athletic field I do not count as such.

I cannot say too much in praise of college athletics. The spare time of a boy cannot be taken up in any better manner. I think that games where the student is assessed $3 to $5 are rare events. The 50 cents admission sounds well enough, since that enters, rather than leaves, the pocket of the student.

When the boy goes out for an athletic team he observes regular hours for sleep and is careful in eating. As a consequence, he enjoys perfect health. College sports not only develop a healthy body, but they in a certain way train the mind. The man who wins a half-mile run is not always the strongest. It is he who has trained himself to stick and use every bit of strength he has in him. I was in the neighborhood of five years older than my fellow students, yet I always enjoyed an afternoon on the field, and took part in races, where I learned many a lesson of patience and perseverance.

If I have a son who wants to become a mechanical engineer, I shall not care if, when he is graduated from college, he knows nothing of machine work, so long as he is trained in mathematics, understands something of human life, and can

meet, and converse on equal terms with other men.

GEORGE STUART.

South Norwalk, Conn.

The Buying of Machine Tools

When the question of new machine tools comes up, the purchaser is often at a loss to decide upon the best tool offered him. The various salesmen tell all about the good points of their tools and by the time the purchaser has listened to several of these eloquent discourses, he is usually as far away from the logical selection as at the beginning. Mr. Osborne, evidently, had the time of his life making a selection of a lathe, after all those tests covering the theoretical pull each lathe was capable of.

This question of pull, brought out by one salesman in trying to sell Mr. Osborne his lathe must have got him all at sea from the way he writes. Of what value is a large theoretical pull if a lathe is not built heavy enough to take care of all this extra pull? The limit of work a lathe is capable of doing is controlled by the strength of the tool and by the steel used in the tool post, and if the lathe will pull all the cutting tool will stand, and do it accurately, it doesn't make any difference how much extra theoretical pull there is, for it is of no value.

In selecting a first-class tool there are several things to consider. The dimensions should be large in order that the tool will stand hard usage and retain its accuracy after several years' of use. If a lathe, the spindle bearing must be large, in order to withstand the pull of the belt and the thrust of the cutting tool without excessive wear. The carriage should have a long bearing on the ways and be bridged strongly to do away with any spring to the tool post. The bed must be built in proportion with the work a lathe is intended to do and, in general, the lathe with the generous dimensions is the strongest tool and will turn out good work in the minimum time, after it has been in use for several years.

Accuracy is extremely necessary in a good tool, and any of the high-class tools on the market are accurate within one to two thousandths of an inch. Permanent accuracy is found only in tools which are properly selected for the work intended to do on them, and if a tool is to be used for general purposes, pick out the one with generous proportions every time.

In the selection of a tool, the work it has to do is a big factor in deciding on the one for the job. A heavy tool to do light work would be out of place, but is far better than picking a light tool to do heavy work. The work you expect to do on a tool ought to, immediately, cause you to decide whether a cheap tool or an expensive one will do, or whether a light or heavy tool will handle the job. This will also help you to decide what equipment you need; in the case of a lathe, whether you need a quick-change geared lathe, or whether a plain lathe will handle the work.

The different "frills" the various tools are equipped with, are like styles in clothes, and do not necessarily make a tool the best tool you can buy. The best tool made is one having the best features for the work you have to do, and the "frills" are necessary in some cases and in others not at all.

Mr. Osborne asks if there are any best tools made. There are, emphatically so. The best tools are in a class by themselves. By this, I mean that machine tools are graded in classes. Take lathes, for instance. There are several fine lathes made, and one is about as good as another, as far as generalities go, but one may have a certain convenience, which the others may have operated in a different way, and that one may strike your eye as the best and most convenient. Then, that tool to you, is the best that money can buy. Your friend around the corner will decide that another is the best on account of the convenient way it operates, and will say your selection is all wrong. Now, take these two high-class lathes you and your friend have selected, and put them side by side, and, under the hands of good operators, they will both do the same accurate work in about the same time.

Why are there so many different designs in machine tools for doing the same work? Because the personal element enters into the design and also into the selection. Just pick out the strongest tool and that is the one with the biggest dimensions and usually the highest price, and you will get the best, provided it is built carefully and has the various features or "frills" you like. There is not a reputable machine-tool builder or dealer in the country who will not tell you honestly how accurate their tools are, and if you take their word for it, and the tool is "out," just let them know, and you will be taken care of in the right way.

Pick out the tool for the job, and do not try to have one tool do too many jobs, unless you are operating a small shop; then, get the proper grade of tools to turn out the class of work you are doing. If you consult one of your shopmen when selecting the tool to be purchased, find out his reasons for making a selection, and see if they are logical. Find out what some of your friends are using, and then weigh the conditions of their purchase. Your man in the shop may never have used the tool you are showing him, and may be afraid to pick it on account of his future. The man across the way may have wanted another tool, but could not afford it. The tool he bought may be all right for the work you have to do, and you may save money by buying it.

Last of all, do not condemn a maker of machine tools if one of his tools you happen to buy goes wrong. Take it up with him in the right way and you may find he is not a pirate. Don't you sometimes, yourself, find one of your customers has a legitimate kick—something which slipped through even when you are as careful as can be and inspect every part during manufacture?

Milwaukee, Wis. F. L. ALLEN.

Auxiliary Jaws for the Lathe Chuck

In admiring F. E. Fick's supporting jaws at page 1169, Part 1, Volume 33, for boring bushes, I notice they are made with elastic braces, and wonder why. I have noticed similar designs in other places, in planing-machine housings, for instance; but fail to understand why the crooked braces are used, when straight ones are more rigid and the patterns cost less. It would hardly seem possible that if a designer could become saturated with the fact Charles T. Porter put into words, "Strains go in straight lines," he would ever bend a brace.

Syracuse, N. Y. JOHN E. SWEET.

Elevator Worm Shaft—Peening Journals—Babbitting Under Ground

I note on page 218, Volume 33, Part 1, an article by D. Lustenberger, wherein he desires information as to the how and the why of a break in an elevator worm shaft. He does not say at what speed the shaft runs, nor in what position, but I assume that it runs vertically and at a moderately high speed, say 500 revolutions per minute.

Now, I am willing to bet a new hat that if he investigates, he will find that his shaft is, or was, not set plumb; further, that it was not in running balance, thereby causing the thrust collars to dig into the shaft. This sounds fishy but I have had precisely the same experience with centrifugal sugar-drying machines.

In sugar manufacturing, the crystals are separated from the molasses in driers on the same principle as the familiar centrifugal clothes drier used in any up-to-date steam laundry. These machines weigh about 200 pounds in themselves and carry a charge weighing about 150 pounds, the entire load of 350 pounds being placed, or suspended, on a spindle. This spindle is of soft machinery steel turned at the end to ¾ inch diameter, and upon this ¾-inch end are placed eight hardened-steel thrust washers, about ⅛

inch thick, 1½ inches outside diameter, and ⅞ inch diameter of hole. These washers take the weight.

The machine runs at 1400 revolutions per minute now, the slightest variation from plumb will start the washers cutting the spindle, and I have found them cut down to a diameter of 5/16 inch, without breaking. The remedy is to hang the spindle vertically, when it will last indefinitely.

Peening the Journals

I observe on page 220 of the same number, an article by E. M. Davids, wherein he substitutes ¾-inch rolls for his bearing metal. My experience along this line has been in connection with sugar-mill rolls. These rolls are driven at a speed of 2½ revolutions per minute, and have a journal 13½ inches diameter and 16 inches long. The pressure on the journal brasses under working conditions is 850 pounds per square inch now, this naturally squeezes out every speck of oil, unless some means are provided for conveying the oil into the bearing, and my experience has been that the bearings undergo periodical changes as to their condition and appearance.

First, take a brand new bearing, polished up to the third degree and looking "nifty." When in this condition the oil naturally will not oil, and in about 24 hours the brass and journal are about as smooth as a second-cut file. What follows is that the roughness of the journal causes it to pick up particles of oil and carry them into the place where they belong, and from that time the bearing gets better and better, working smoother all the time, till it reaches the dead smooth stage, when the process is repeated. The brasses are water jacketed and the oil used is a heavy mineral oil.

Working along these lines, I have at times wilfully and with malice aforethought, and when the boss was away, pounded the bearings with a ball-peen hammer (the journals, not the brass), when it began to get hot, so as to hurry up the cutting process and get the bearing to oil itself. The result has always been good.

This is not theory; it is practice, and if you don't want to try it, you don't have to. I certainly admit it "listens queer."

Babbitting Under Ground

Perhaps some of your readers have had occasion to rebabbitt a box in a hurry, and as the box was an odd shape and the proper rig was not to hand, they have gone through the usual performance of shimming the mandrel in position and plastering mud around the outside to retain the babbitt. The usual result is that as soon as the box is full the weight of the babbitt forces the mud away and the babbitt goes into one's shoe and gets up the leg of one's pants; unless it takes the other direction and gets one hot under the collar in various ways.

I have found it highly expedient to dig a hole in the floor of the smithshop and bury my box, all but the pouring hole, tamping the dirt down well. The babbitt is never lost and when cool you just naturally dig it up again.

Kailua, Hawaii, H. I. Sugarfactor.

Some Points on Cold Rolled Shafting

I read with interest the article under the above heading by Chas. C. Klein, on page 973, Part 1, of Volume 33, as I have been devoting some time lately to this subject. In this country, shafting is not the principal use that cold-rolled steel is put to. It is used mostly for bolts, studs and pins of all shapes and sizes, that are manufactured in automatic and turret machines. Most shafting here is turned in machines specially designed or rigged for the work, in many cases one man looking after three or four machines.

My troubles with the so called cheap cold-rolled steel were not in the direction of shape or accuracy, so much as in the material itself. What we got was fairly round and straight, not varying more than one-thousandth in diameter and not out of round more than that amount.

Our trouble came when a bar rolled off the railway truck and fell on the shop floor and broke in a dozen pieces. On testing other bars by tapping them against an iron block, a piece jarred off at every blow.

This steel was imported and needless to say was returned. We then sent to various firms for samples and specified mechanical tests and analysis, and tried several. On selecting one of these we thought we had overcome our troubles. Although the steel gave excellent results in the tests, we had customers complaining that studs and bolts were frequently breaking.

We then adopted what we call the oil-quenching treatment, and have had no trouble since, after over 18 months' use. The treatment consists of heating the parts, after they have been machined, to a temperature of from 1200 to 1350 degrees Fahrenheit (blood red), and then quenching them in whale or sperm oil.

After this treatment they can be polished, if necessary, but studs, etc., require no treatment after the quenching. They are simply drained and ready for use. The result of this treatment is a more ductile material and large studs and bolts are relieved of all strains set up by the dies in threading. There is a slight loss in tensile strength, but as the material is well over the specification this is not serious.

We make mechanical tests of every consignment of cold-rolled steel we buy, and the following is a fair average. We test specimens straight from the bars, and specimens that have been oil-quenched:

The following is an approximate analysis of the last three consignments:

Carbon, 0.09; silicon, 0.013; sulphur, 0.045; phosphorus, 0.05; manganese, 0.45.

	Diameter.	Tensile Strength in Pounds per Square Inch.	Elongation in 2 Inches.	Elongation in 8 Inches.	Bending Over ¾-inch Rod.	Fracture.
Oil treated	0.504	78,400	34%	28%	180°, no sign of fracture.	Silky.
Untreated	0.504	83,800	23%	15%	120°, signs of fracture.	Silky.

On bending a treated specimen through an angle of 90 degrees, it stood 13 bends before breaking and the break gave the appearance of wrought iron. A similar specimen, untreated, only stood about one-quarter of what the treated specimen stood.

We now have no trouble whatever with this steel. It fulfils all Government requirements for mechanical tests, and the trouble, which appeared to be the fatigue of the material, is disposed of.

I may say we used cold-rolled steel for cam shafts on gas engines up to a year or so ago, but met none of the troubles that your contributor mentions, although the load on these is applied locally at various points, and would tend to make the shaft run out of true. The reason we have given up its use for this purpose is because we find it cheaper to turn from black bar.

There was another point that your contributor omitted to mention and that was the matter of seams in the bars. My experience is that when seams show themselves in a bar, one can look around for more bars with the same complaint, as this is due to faults in the ingot before rolling, and the possibility is that all the bars from that particular ingot will suffer in a similar manner.

George Hey.

Nottingham, England.

In a paper on air brakes, by W. E. Turner and S. W. Dudley, the amount of energy absorbed by an air brake constructed on the latest lines is illustrated by a diagram showing that an engine which consumed nearly six minutes to get up to a speed of a mile a minute, in a distance of 3½ miles was stopped in 18½ seconds, the train being brought to a dead stop in less than 1000 yards.

Mechanical Engineers in England

Editorial Correspondence

A successful joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers held at Birmingham, England.

Important subjects discussed were high-speed and machine tools, tooth gearing, involute-gearing tooth standard.

It is eminently fitting to begin the report of the joint meeting of the Institution of Mechanical Engineers of Great Britain and the American Society of Mechanical Engineers by a reference to the eastward ocean trip of the greater number of the American members, that began Saturday, July 16.

The committee of arrangements, Past President Ambrose Swazey, chairman, spared no pains to make the trip memorable to everyone. The weather and sea conditions were of the best and the "Celtic" lived up to her reputation as an exceptionally steady ship.

The party on board numbered 153 members and their guests, and it was regretted by everyone that business prevented President George H. Westinghouse from attending.

In addition to the enjoyment of renewing old acquaintances and making new ones, games and tournaments, dances, a musicale and two lectures were heartily appreciated.

Past President W. R. Warner gave a lecture on the "Advances in Astronomy," illustrated by several recent photographs and aptly touching upon the connection between the science of astronomy and the art of navigation.

Past President John R. Freeman gave an illustrated lecture on the "Panama Canal." Many of the photographs were of the cement work of the huge locks and gave a striking impression of their massiveness and stability.

Souvenirs of the Voyage

About noon on Saturday, Commander Hambleton and Chief Engineer Lapslea became the honored guests of the society for a few minutes, were thanked for the many kindnesses shown to the party and presented with souvenirs of the voyage—the commander with an engraved silver box, the chief engineer with a desk lamp.

The last week-day evening on board, Saturday, July 23, was given over to a final good time. The prizes won in the games and tournaments were presented with appropriate remarks and received with equally appropriate replies.

A humorous lecture was given by Past President James M. Dodge and a few original verses were read by Past President F. R. Hutton; these, with music, filled out a program that received the heartiest of applause.

The Welcome at Liverpool

Liverpool was reached late Sunday afternoon, July 24. A tender came down the river to meet the "Celtic," having on board President J. A. F. Aspinwall and several other distinguished members of the Institution. An informal meeting was at once held in the saloon of the steamer.

The deputy lord mayor of Liverpool, John Lea, extended a cordial welcome on behalf of the city of Liverpool to the visiting engineers, addressing them as brethren, brethren in the double sense of race, language and the great intercourse taking place between them in a professional sense.

President Aspinwall extended a welcome on behalf of the Institution of Mechanical Engineers, saying that they had been looking forward to this visit for a long time. He characterized the British as an acquisitive nation and hoped that the American engineers would leave behind them a great volume of good ideas. At the same time he assured the visitors that on their part the British would gladly impart any information that might be desired.

Professor Watkinson, on behalf of the University of Liverpool, welcomed the guests and paid an eloquent tribute to the research work carried on in American universities and technical schools.

In acknowledging these warm greetings Professor Goss expressed the sentiments of the American party by characterizing them as the culmination of the events of a most enjoyable voyage.

Proceedings at Birmingham

Monday morning, a special train conveyed the party to Birmingham. The afternoon was given over to registration and getting settled in the hotels. A very attractive badge was presented to each of the visitors.

As the arrival at Birmingham marked the closing of the arrangements made by the committee of the American Society of Mechanical Engineers, it is fitting at this place to say a word of appreciation of the excellent manner in which everything was planned and carried out. All of the plans went through without a hitch, thus indicating the painstaking care with which they were worked out, and expressions of approval were heard on every hand.

Tuesday's Professional Session

This first professional session in Birmingham was opened by an address of welcome by Lord Mayor Bowater. At the close of his greetings and wishes for a pleasant stay in the city, he introduced George Tangye, Esq., the present owner of Heathfield Hall and custodian of the James Watt relics. In a few appropriate words Mr. Tangye presented to the American Society of Mechanical Engineers a letter written by James Watt. The letter is in a splendid state of preservation and is clearly legible.

After a few words of appreciation from President Aspinwall, acknowledging the kindness of the city of Birmingham in connection with the meetings, Professor Goss, on behalf of the American visitors, acknowledged the many greetings and thanked Mr. Tangye for his priceless gift, saying that it would be one of the treasures of the society in its new fireproof home in New York City.

The professional papers and discussions were upon the subject of locomotive running, shed practice, and only need mention here. At 1 p.m. luncheon was served in the Town Hall, and the afternoon was given over to sightseeing.

Visit to James Watt's Home

George Tangye most kindly opened his home, Heathfield Hall, the home of James Watt in his later years. Here are many relics of the eminent engineer and inventor, including the attic workshop, which is kept as he left it. There are probably few as interesting places for engineers to visit as this, and this second courtesy of Mr. Tangye was warmly appreciated by all who availed themselves of his kind invitation.

Many excursions were planned for each day of the meetings, but obviously they cannot even be mentioned here. Meanwhile, special attentions were shown the ladies, and motor rides and visits to points of interest were enjoyed during the hours of the business sessions.

Tuesday Evening Garden Fete

In the evening the botanical gardens were thrown open for a garden fete at which the lord mayor and lady mayoress received. Hundreds of lanterns decorated the grounds, a collation was served and the evening closed with a fire-works display.

Wednesday Session

This session was devoted to machine-shop subjects, three papers being presented that will appear in these pages in the near future.

Mr. Brackenbury's paper on "High-speed and Machine Tools" was followed by a topical discussion by three American

members, John Calder, Luther D. Burlingame and L. P. Alford.

Mr. Wickteed in discussion compared the advantages and disadvantages of planers with a speeded reverse, and those arranged to cut on both strokes. He summed up the situation by expressing the opinion that the speeded reverse is advisable for machines having platens up to 4 or 5 feet wide and 15 to 20 feet long, and that the double tool box should be used on planers of large size.

Mr. Steven's paper on "Tooth Gearing" and Wilfred Lewis' on "An Involute Gearing Tooth Standard" were presented in brief abstract, which also will appear subsequently in these pages.

In discussion Mr. Vernon, member of the Institution, mentioned the many experiments and difficulties that his firm has had trying to make silent gears. He expressed the hope that the two engineering societies would, though their committees, work out an international gear standard.

A written discussion by Mr. Gabriel, of the society, recommended that well enough be let alone, and stated that the so called Brown & Sharpe standard is satisfactory. In further discussion of the subject Mr. Burlingame took the same position.

A luncheon, sight-seeing trips around the city and a reception in the Town Hall at the invitation of the lord mayor and lady mayoress closed the Birmingham meetings.

Society of Automobile Engineers

Editorial Correspondence

A successful meeting at which the following papers were presented and discussed: Pyrometer, Development and Use; Heat Treatment of Steel; Slide Rotary and Piston Valves versus Poppet Valves for Gas Engine Service; Cork Insert Pulleys; Testing Air-cooled Engine.

The midsummer convention of the Society of Automobile Engineers, as held in Detroit, Mich., July 28, 29 and 30, was considered the most successful, both from a technical and social point of view, ever held by this society. Automobile engineers of note from all parts of the country were present. Each session was well attended and some lively discussions were brought up by several of the papers that were read.

Following the opening address by President H. E. Coffin, on Thursday morning, the regular business meeting was held, in which reports by the various committees were given.

Thursday Afternoon's Session

The first address or paper was given W. H. Bristol on the "Pyrometer, Development and Use." Mr. Bristol had for exhibition several types of pyrometers and auxiliaries, also a furnace for demonstration. An interesting history of the development of this instrument was given. The various types in common use were described with their peculiar advantages. One of the points brought out by this talk was that the extension to the fire-end should be carried to a point at which a constant temperature may be maintained before connection is made to the wires leading to the pyrometer.

The regular mercury compensator was shown, and a demonstration was made with a new form of compensator that is practically indestructible and has just been perfected by Mr. Bristol. An instrument for determining the critical point of any steel from a sample was demonstrated, also a rapid-reading pyrometer that would give the temperature reading within a few seconds. This instrument is well adapted for exploring various portions of the furnace. Mr. Bristol laid special stress upon the location of the fire-end. This should be as near the work as possible and, as suggested by Henry Souther, in the discussion that followed, it is well to place the fire-end on the work as it lies in the furnace. He further calls attention to the fact that common sense must be used, no matter how accurate the pyrometer may be.

Mr. Souther's paper on the "Heat Treatment of Steel" was not read, as it consisted principally of an attempt to standardize and classify the different grades of steel used in automobile construction, with experiments made with the different grades given in tabulated form. His general talk upon the subject, however, was of special interest. He called attention to the impracticability of many specifications for steel which entail unnecessary delay and expense, among them being that steel manufacturers should be given a leeway of 0.10 per cent. on the carbon content, and that a specification calling for phosphorus and sulphur below point 0.04 per cent. means an expensive delay and a high-priced material.

The various processes of manufacturing steel were described. The Bessemer, basic and acid open-hearth, and crucible processes of steel making were outlined with the special uses for each. It was pointed out that the electric furnace is a real advantage in the manufacture of steel. Mr. Souther contends that with the same amount of care as good a steel may be produced by the open-hearth process as by the crucible process, although, as a rule, this is not the case. A case was cited where a number of drills, made from both of these kinds of steel, were practically of equal efficiency. He states, however, that the open-hearth steel was given special attention at all points of its manufacture. In general, the lower quality of the open-hearth steel is principally due to hogging methods used in rolling, and to overheating, it being produced in much larger quantities. Mr. Souther told of an excellent razor, now being used by him, that was made of open-hearth steel. "However, intelligence had been used all along the line until I received it." (Great applause.)

Proper heat treatment is just as essential in the manufacture of steel as in the handling of the finished product. No steel should be used in a car that has not been properly heat treated. The use of expensive steels in their normal condition was deplored when the same results might be obtained from ordinary carbon steels, properly treated. Also the same grade of steel may be used throughout the car, except for the springs, by varying the treatment according to the use to which the steel is to be put. A flange, or a necessarily sharp corner, it was pointed out, requires special treatment for any grade of steel. It was stated that 50-point carbon steel could be successfully used for case-hardened parts but it is not to be recommended if other steels are available.

Stress was laid on the importance of the alternate-stress test for automobile steel. In order to save time in making such tests it is recommended that the steel be loaded to within two-thirds or three-quarters of its elastic limit.

Mr. Southers also mentioned a recent discovery in iron ore that contained a comparatively low percentage of chromium and nickel. This is expected to greatly hasten the production of a good cheap alloy steel. He praised Mr. Bristol for his work on the pyrometer and recalled the extreme difficulty with which the instrument was first introduced. The tendency now, however, is in the other direction and very much so. He believed that the use of the pyrometer is now carried to extremes, but that the pendulum will soon find a proper balance.

Mr. Shore's paper, on "Testing Hardness of Metals," gave a brief outline of the various methods employed to detect the hardness of materials and it explained a little more fully than has as yet been done just what hardness is as judged by the scleroscope. This paper gave a list of the hardness standards that are used for various parts of a car by some manufacturers. The instrument was then demonstrated by T. G. Kindell.

A lively discussion followed the reading of the paper. Among the points brought out in the discussion were: That the instrument must be placed normal to the piece being tested; that the surface must be smooth; that the depth of hardness, also the contour of the surface and the section of the piece will affect the reading.

Thursday Evening's Session

Charles T. Terry's address on "The Basis for Motor Car Taxation" and the discussion following took up this entire session and was a notable feature of the convention. His preliminary address, outlining the woes of the poor automobilists, was enjoyed by all.

One point clearly brought out was that the wear on the roads is due more to speed than to weight. This is confirmed by data received by the engineers of the Michigan Central Railroad, who state that "the wear is much greater on the high-speed passenger tracks than on the slow-speed freight lines carrying four times the load." Mr. Terry calls attention to the fact that our roads were really never used before the advent of the automobile and wonders how this question would be looked upon if the horse were just being introduced instead of the automobile. In the discussion Mr. Southers contended that "the horse was a wild beast, anyhow, and should be abolished."

After considerable discussion, the question as to a proper basis for motor-car taxation was referred to a committee for consideration as no one seemed prepared to advance many suggestions along this line.

Friday's Session

On Friday morning, those attending the convention visited the various automobile plants in the city, each person having a choice of three routes. Special preparations were made at the various plants for entertaining the visitors. At 1 p.m. the entire party took a steamer up the Detroit river as the guests of the Timken-Detroit Axle Company. The steamer went across Lake St. Clair, up to the Flats, where a frog dinner was served. It was a most enjoyable trip although so windy that the professional session scheduled for the afternoon could not be held. During the return trip the conditions were better and several interesting papers were read.

D. F. Graham's paper on "The Variation of Current Practice on Anti-Friction Bearings" gave a list of the various sizes now in use for automobile bearings. This list was compiled from a number of cars. Mr. Graham called attention to the increased delay and cost that are occasioned by the use of specially designed bearings and pointed out the possibilities of standardization in this line.

E. J. Stoddard's paper on "The Establishment of a Court of Patent Appeals" was then read. This is proposed as the remedy for our Patent Office trouble. It advocates creating a court of final resort, to hear appeals in patent cases and take the place of nine or ten courts of appeals that now exist, with their conflicting opinions and numerous disadvantages. The bill creating it has been favorably reported on by the House committee on patents and by the Senate committee on patents. It has been referred to the judiciary committee of the House and is now before that committee.

F. A. Ward's paper, "Making Gears Quiet by Grinding," brought out considerable discussion. This paper contained a brief description of a gear-grinding machine for spur gears only, after outlining the need of such a machine and a history of its development.

The emery wheel is turned to the form of tooth desired by diamond points, the movement of these diamonds being controlled by steel forms. These steel forms are developed from a templet several sizes larger, thereby insuring accuracy in form; otherwise this machine operates very much on the principal of the regular spur-gear cutter. An especially accurate and positive indexing mechanism is provided.

During the discussion following this paper, Mr. Ward stated that the extra cost of grinding the teeth after the gears had been hardened is made up by the time that may be saved in assembling them as no preliminary fitting or grinding is required. This machine is not for sale, but the Gear Grinding Company is prepared to take care of all work under 12 inches diameter. It is now at work on a machine for grinding bevel gears.

H. S. White's paper on "Seamless Steel Tubes and the Necessity for Standardization in their Specification" called attention to the large number of steel tubes originally specified by automobile engineers. This number has now been greatly reduced. It is thought a still further reduction might be made. To this end, a table of 300 sizes is submitted. This matter has been referred to a committee.

Saturday Morning's Session

L. R. Smith's paper on "Test Data upon Sheet Metal Frame Sections" contained the results of tests on various grades of machinery. This matter is printed in tabulated form and should be of general interest to the trade. This was followed by a paper by F. D. Howe on "Ill Smelling and Smoky Exhausts," bringing out various reasons for this trouble and suggesting remedies. A great deal of this trouble seems to be in improper handling of the carbureter.

The paper following was by Eugene P. Datzell, on "Slide, Rotary and Piston Valves versus Poppet Valves for Gas Engine Service," and it provoked considerable discussion. The next was a paper by T. V. Buckwalter, on "Motor Trucks for Railroad Service." This paper was of special interest, showing the progress that has been made in this direction. This is a branch of the automobile industry that has apparently been receiving little public attention and one is surprised at the advance made. The motor trucks have proved superior to the old method under all conditions. As applied to railroad service, the motor truck may be classified into three groups, as follows:

First. Trucks utilized to replace box cars in the transfer of freight between different stations in the same city.

Second. Trucks to replace horse-drawn vehicles in the transportation of both passengers and merchandise on the public highway.

Third. Trucks to replace manual labor in the handling of baggage and mail in large stations, machinery and supplies in railroad shops, and in the transfer of freight in large freight and transfer stations.

Saturday Afternoon's Session

The first paper read at the afternoon session was on the "Standard Automobile Nomenclature," by F. E. Watts. It is pointed out that there is little uniformity in naming the different parts of the automobile. For instance, the piece that supports the front wheel is varyingly called steering pivot, knuckle, front-wheel spindle, etc. It is suggested that a committee be appointed to go into this matter and recommend a designation for at least the principal parts of the different types of cars. Repair departments and automobile users will appreciate this work as an endless amount of confusion may be avoided in filling orders.

Another subject discussed at that session was "Driver's Seat on the Left versus Driver's Seat on the Right." This led to some discussion, but no definite conclusion was reached. Other subjects generally discussed were "Leaf Springs, Method of Mounting," and "Magneto Efficiency."

A paper by Lawrence Whitcomb on "Cork Insert Pulleys," was of interest and should be of value to the machine trade in general. He gave the result of rather extensive experiments made with this type of bearing. It will be printed in full in a later issue.

A paper by H. H. Brown, on "The Carrying of Tools and Spare Tires on the Car," was of interest to automobile users, as it outlined the necessary parts to carry and the most convenient and safe way of carrying them. Other subjects brought up for general discussion were "Single versus Dual versus *en Bloc*

Cylinder Construction"; "Foreign Matter in Commercial Gasolene"; and "Practical Experience with Fixed Ignition Timing."

There were many other interesting subjects proposed for general discussion, but owing to the lack of time, they could not be reached. It is the unanimous opinion of the society that the midsummer meeting was one of the best attended and that Detroit is an ideal convention city.

Horizontal-Vertical Dividing Chuck

By F. J. Bostock

A labor saving tool designed so as to allow greatest possible clearance between chuck and milling arbor.

The illustrations show a type of dividing chuck, which has met with considerable success during the past few years, and shown itself to be a good time and labor saver. The primary idea in designing it was to supply a need for such a tool which should be cheap, of good capacity, large central bore, reliable, foolproof, at the same time to be as low as possible, in order that the clearance between itself and the milling arbor should be as great as possible.

From an examination of Figs. 1, 2 and 3, it will be seen that the device consists mainly of three parts. *A*, Fig. 3, is a Cushman chuck and the illustrations show a 9-inch size. This chuck is registered, secured and doweled to an index plate *B*, which for ordinary purposes is indexed into twelve parts to give 2, 3, 4, 6 or 12 divisions, but, of course, can be indexed to suit any job in hand.

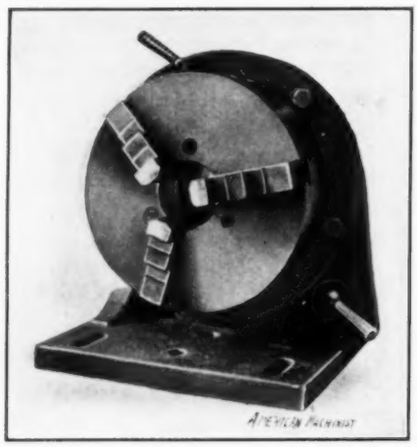


FIG. 1. THE CHUCK IN HORIZONTAL POSITION

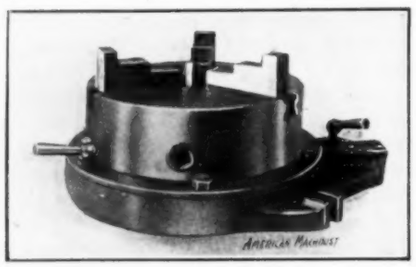


FIG. 2. THE CHUCK IN VERTICAL POSITION

A rack plunger *D*, operated by a pinion *E* serves to locate the positions of the index plate, while the whole is bedded into the base *C*. The locking screw *F* clamps the top ring, plate and base together, if necessary.

Owing to the constant employment of these attachments upon drilling, milling, slotting, shaping and other machines, and for special lathe jobs, I found it necessary to increase the stock of them and to make a few with the chuck vertical, all of which were made interchangeable with each other. This latter type is extremely useful on the milling machine for the purpose of holding arbors, shafts, etc., in fact nearly everything that is circular.

With care, these tools keep their accuracy for a long while, during which time they are used to a large extent in place of the ordinary dividing heads.

By using the base and the indexing plate, the arrangement provides a good and cheap means of making fixtures, for dealing with circular dividing work, whether for milling, drilling or slotting operations.

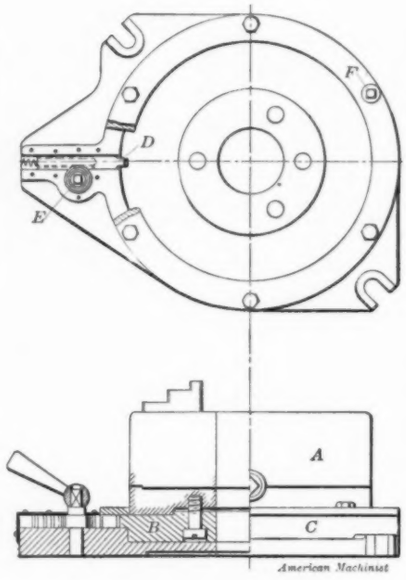


FIG. 3. CONSTRUCTION OF DIVIDING CHUCK

A Shop System for Foreman and Superintendent

Cases of interference in shop system indicate very emphatically the need of a general underlying shop system instead of a system in shop departments each independent of other departmental systems. But the worst system, or perhaps lack of system, is the pernicious practice which exists in many shops, of the superintendent giving orders direct to the men instead of through the foreman.

The procedure above noted always leads to confusion and to the considerable increase in cost of the work thus performed. Any man who is fit for the position of machine-shop foreman is capable of placing work in the hands of each man which is best fitted for the personality of that man. The superintendent, although he may be as good or even a better man than the foreman, cannot assign work to men with as good results as can be done by the shop foreman. The reason for this is that in order to be of value in the business, the superintendent cannot spread himself over the shop thinly enough to be conversant with the peculiarities of each workman. When the superintendent permits himself to be thus spread out so as to handle details, his usefulness as a superintendent is greatly impaired and he is not doing his duty to his employers.

This point should be firmly fixed in the mind of each and every superintendent by his "owners" and he should always keep that idea in full view. When he does this, and fully realizes its importance, then he will be able to turn out the maximum quantity of work with the minimum labor bill, and he will never be guilty of paying 35 cents an hour for a 25-cent job. Lots of this can be seen in many different shops, some of which pride themselves upon their "systems" and upon the perfection of the internal organization. How is it in your shop? Has the "system" screw become a bit loose in spite of your vigilance? If so, tighten it at once.

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American Machinist

Editorial

Running Balance

We believe that we are peculiarly fortunate in being able to present to our readers the leading article in this week's issue. The question of balance for machine parts has always been treated with obscure explanations. This article sets forth the well known underlying principles literally, in a new light, for they are presented through a visual demonstration.

By way of emphasis we repeat these principles: "All rotating parts of high-speed machinery should be running balanced.

"A part in running balance will also be in standing balance.

"A part in perfect standing balance may be very far from being in running balance.

"The operation of standing balancing may be a detriment instead of a benefit to high-speed machine parts.

"A part in running balance at one speed will be in running balance at all other speeds, provided it does not distort from centrifugal action.

"Exact symmetry of form is no guarantee of running balance.

"High-speed rotating parts should be so designed that they will not distort from centrifugal action if rotated free at any speed at which they may run in use, and thus destroy a state of running balance."

The machine designer should carefully note the last. How often does he take the trouble to figure the centrifugal forces set up in a rapidly rotating machine part at the speed at which it will run? Such instances are probably very rare. Referring to the automobile where balancing is supposed to be of the best in order to get quiet running cars, what shall we say of the conditions discovered by the Norton running-balancing machine, that the ordinary four-throw crank shaft bends something like 1/16 of an inch at the very low speed of 1200 revolutions per minute? This means that the crank-shaft bearings are obliged to resist such bending actions with their consequent tendency toward excessive vibration and rapid wear.

To the engineer, production superintendent and foreman, we commend the third principle quoted above. Standing balancing is very common as an operation in making high-speed machine parts. No argument is needed beyond the article that we are mentioning to show its absolute futility. Standing balancing alone should be banished as a machine-shop operation.

Wasted Energy and Wealth

It may not be immediately apparent that there is any connection between mechanical matters and the recent brutalities at Reno. Two things impress us, however, one because many say, as in every such case of what Elbert Hubbard would call conspicuous waste, that it is a good thing to put money in circulation, no matter what the means.

We feel that all accumulated wealth is directly due to well directed labor in a greater or less degree. The value of the coal that we burn under the boiler is made up mainly of the labor which it has taken to place it there. Now, if that coal is burned under the boiler it may aid other labor to produce more wealth, while on the other hand, if it is wantonly wasted by being burned out in the yard where no benefit can come, then just that amount of labor has been wasted that its value represented.

Every dollar that is spent in unnecessary clothing, food, drink, or other useless show or for anything that produces economic ashes is simply a destruction of men's labor, which can never be replaced. So, too, with our machinery and our shops. A man may have accumulated or in some way have come into the possession of a fortune. He spends it in building up a shop. He places it in the wrong place, he buys the wrong equipment. He runs for a while, spends his fortune, always hiring labor, to be sure, always buying the results of other men's labor, but so surely as he fails and his buildings are left to decay and his machinery to rust out, he is robbing the world of the accumulated labor which should have helped us on toward the abolition of poverty.

The other thing lies in the fact that Jeffries did not "come back." How many of us have not "come back?" We may have worked, struggled to make our way, we may have had a bit of success and have lain on our oars to drift with a favoring tide only to find that every tide turns and that every man some time or other faces head winds and adverse tides. We find ourselves enervated and unfitted

to fight the battle over again, and we are knocked out usually long before the fifteenth round.

What a man needs to keep his body or his mind in active readiness to meet emergencies and stave off disaster is constant training. Not overexertion, but a daily contact with the things of business or mechanical life that keep the rust away and every nerve and sinew in a state of calm and instant readiness to do the work that may come, no matter how powerful or how ample the fortune that may be at apparent command.

How Much Is Up to the Maker?

The introduction of special machines, automatic or otherwise, led to marked changes in the methods of buying and selling machinery. It was quite natural that the buyer should be skeptical and want to be shown in his own shop that the machine could do all that was claimed for it and very necessary and proper that the builder should convince him by sending a machine and an operator. But in many cases these practices have developed abnormal conditions which are neither fair to the builders nor helpful to the user.

After a machine has been started to work by the demonstrator and proved to be capable of doing the work for which it was purchased, the builder's part of the contract would seem to be fulfilled and its further successful operation is the obvious duty of the purchaser. And except for the development of defects in materials or workmanship within a reasonable time, he would seem to have no further claim on the maker of the machine.

In too many cases, however, the builder is expected to make good worn out parts, to send a man hundreds of miles when anything goes wrong and incur other expenses which was never considered a part of the builder's duty with the plain machines like the engine lathe and the planer. More than one builder can cite instances of sending men to distant points to find that a bearing had never been oiled, that parts had been bruised so that they would not work properly, or other equally exasperating things which cost money but which the user never expects to pay for.

Builders are very glad to suggest methods of using their machines and to plan ways of doing work, but after this has been done it is more than exasperating to find the user complaining that the machine is not making good, only to find that the class of work has been changed and no judgment has been used in making fixtures or tools. In one case the user admitted that he sent for the demonstrator because he knew his shop was in a bad way and wanted to get methods reorganized. Yet he refused to buy additional machines of that make if the services of the demonstrator should be charged for, although it was a clear case of getting a systematizer for nothing.

But there is another side to the story and the user who puts it all up to the builder is paying part of the penalty. If, instead of helplessly wiring for the builder to send a man, he would go to work and get the machine going with his own men, he would gain in two ways. The machine would be idle a much shorter time and he would not acknowledge to his men that he was helpless without the builder's expert. Every shop should have men capable of tuning up any machine that gets out of order, as it keeps the production up nearer the standard and is better in every way than depending on any man from the outside.

This is a question on which both buyer and seller can get together to their mutual advantage. The best interests of the industry demand perfect fairness on both sides, especially as the buyer of one kind of machines is of necessity the seller of whatever machines they produce and may be in the same boat himself with regard to his own customers.

The Cooperative Plan at the University of Pittsburg

We are in receipt of a copy of the University of Pittsburg bulletin, containing an outline of the coöperative plan of engineering education as adopted by that institution. No very precise particulars are given, but we read that "the faculty of the School of Engineering have matured a coöperative plan whereby the student, while spending in school the amount of time usually devoted to instruction in our best engineering institutions, will work four terms of three months each in the engineering industries of the Pittsburg district . . the school work being arranged so that successive groups of students will furnish continuous service to the employer."

This plan will be seen to differ materially from the one in use at the University of Cincinnati. Except that it is to be better organized, it does not, so far as the individual student is concerned, differ materially from the practice of many engineering students in other institutions in devoting themselves to shop work during the summer vacation. At the same time the coöperation of the university, coupled with its location in such an industrial center as Pittsburg, will add materially to the value of the work and also relieve the student from the necessity of finding suitable vacation work, which, in the past, has been in many cases a serious matter.

In his relation with the factory where he is employed, the student will be a direct employee and will work under the conditions of the regular force of workmen. It is expected that the wages received will be sufficient to pay the university tuition charges.

New Publications

The Art of Aviation. By Robert W. A. Brewer. Two hundred and fifty-three 5½x8½ pp. Ninety-four illustrations in the text; 12 plates of diagrams; numerous tables; indexed. McGraw-Hill Book Company, New York City. Price, $3.50 net.

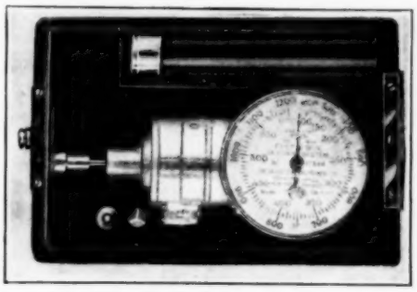
The author's preface states that this book has been written to deal more with the practical aspect of flying machines than with the theoretical, and that it is intended to interest a majority of the thinking public. The work lives up to this statement of purpose, as the theoretical side of mechanical flight and aërodynamics is only briefly touched upon in explaining some of the essential differences between various aëroplanes and propellers. A limited amount of historical matter is introduced in the early part of the book, dealing more particularly with the designs and patents of Henson, whose important work seems to have been done between 1835 and 1845. Following this the question of engine design is carefully treated, types are differentiated and all of the well known makes are described in detail, these descriptions, in some cases, extending even to manufacture and construction. Two chapters are devoted to the propeller, giving first the theory, and second descriptions of several well known kinds. The second chapter closes with a table of propeller efficiency. The two succeeding chapters are devoted to the materials used in the construction of aëroplanes and details of manufacture. Then follow three chapters, describing some 10 or 12 of the more successful monoplanes and biplanes. The closing chapters give in neatly tabulated form monoplane and biplane records up to the date of issue, a discussion of the use of the glider in learning the art of flying, a glimpse into the possibilities that lie before the airship, with particular reference to the art of warfare, and finally a glossary of technical terms used in connection with airships. This last should be of particular value to English-speaking readers for many French expressions have already crept into the aëronautical vocabulary. Finally, an appendix of eight pages gives a notation for the various quantities used in computing air resistance and aëroplane proportions, several useful tables and a number of formulas covering aëroplane design. To an American reader it may seem that too little emphasis has been laid upon the pioneer work of the Wright brothers, but this may be explained perhaps in stating that the book is of English origin.

New Tools and Shop Appliances

The Horn Cut Meter and Tachometer

The halftone shows a tachometer made by Theodore Horn, Leipzig, Germany, and handled in this country by the Industrial Instrument Company, Foxboro, Mass.

This handy little instrument, with one nurled disk for obtaining surface speeds



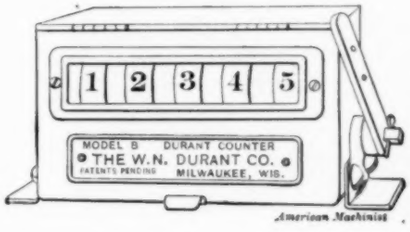
THE HORN CUT METER FOR SURFACE SPEEDS AND SPINDLE REVOLUTIONS

and two centers for obtaining the speeds of shafts, weighs less than 13 ounces. The body is made of aluminum and the handle of ebony.

The outer figures on the dial of the instrument shown give revolutions per minute from 200 to 1200 and the inner figures give surface speeds in feet per minute from 100 to 600. The instruments are made in practically any capacity and to read in any desired unit.

The Model B Durant Counter

The counter shown in the line cut is built by the W. N. Durant Co., Milwaukee, Wis. It is of the full geared type, without springs, and is provided with



MODEL B DURANT COUNTER

a quick resetting device which leaves the gears constantly in mesh. It is four inches long by two and one-half inches high, can be operated on a very short stroke and is accurate at high speeds.

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

New Scott Tempering and Hardening Furnaces

C. U. Scott, of Davenport, Iowa, has added to his line of furnaces the lead-bath hardening furnace, shown in Fig. 1, and the tempering furnace, shown in Fig. 2, which is arranged so the heat can

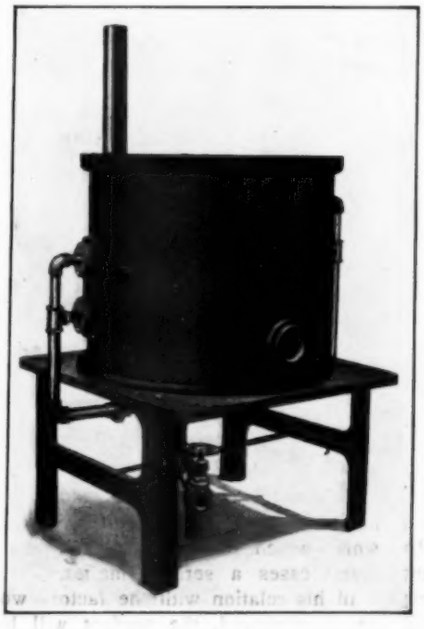


FIG. 1. SCOTT'S LEAD BATH

be easily controlled and when held at the exact temperature desired for any length of time. A new feature has

FIG. 2. TEMPERING FURNACE

been added to the lead bath by arranging it so it can be used as a hardening furnace as well as for bluing.

A Large Horizontal Boring Machine

The halftone shows a special machine for boring turbine cylinders, from 2500 to 2800 millimeters (about 8 to 9 feet) diameter. The bed of the machine is 3500 millimeters wide by 10,500 millimeters long (about 11 feet 6 inches by 34 feet 6 inches) on which the outboard support is mounted.

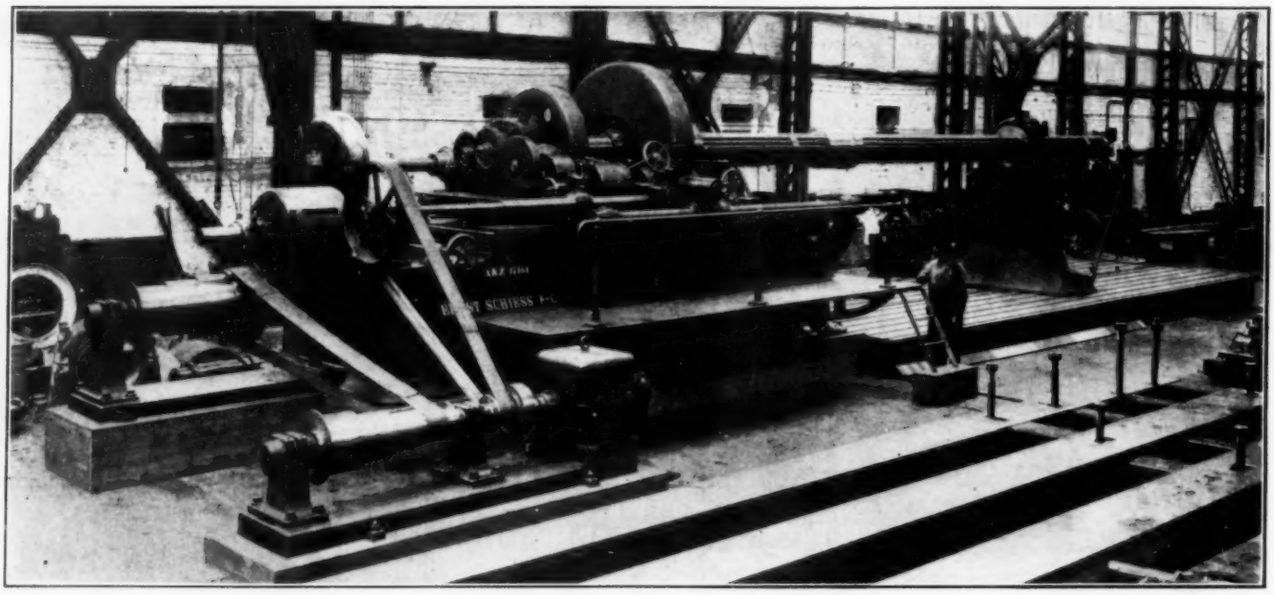
The headstock is mounted on ways, has a traverse of 2500 millimeters (about 8 feet 4 inches) for boring, and also a quick traverse by power. The drive is from a 30-horsepower motor through a four-stepped pulley and gearing. The boring head is moved by two screws, one in front and one at the back. Eight feeds are provided, from 0.15 to 5 millimeters

(about 0.006 to 0.2 inch) per turn of the spindle. The headstock is also provided with fine adjustment by hand.

The main spindle is of forged steel and runs in adjustable boxes 350 millimeters (about 13 13/16 inches) diameter by 600 millimeters (about 23½ inches) long.

The boring bar is of the usual type with a head traversed by means of a screw. The distance from the center to the bed is 2200 millimeters (about 7 feet 4 inches). The drive of the spindle is by worm and worm gear, the worm running immersed in oil.

All levers and handwheels are located in front conveniently for the operator. All gearing is machine cut. This machine weighs 85,000 kilograms (about 178,500 pounds) and is built by Ernest Schiess Werkzeugmaschinenfabrik A. G., Düsseldorf, Germany.



A Large Horizontal Boring Machine

Carbonizing Compound

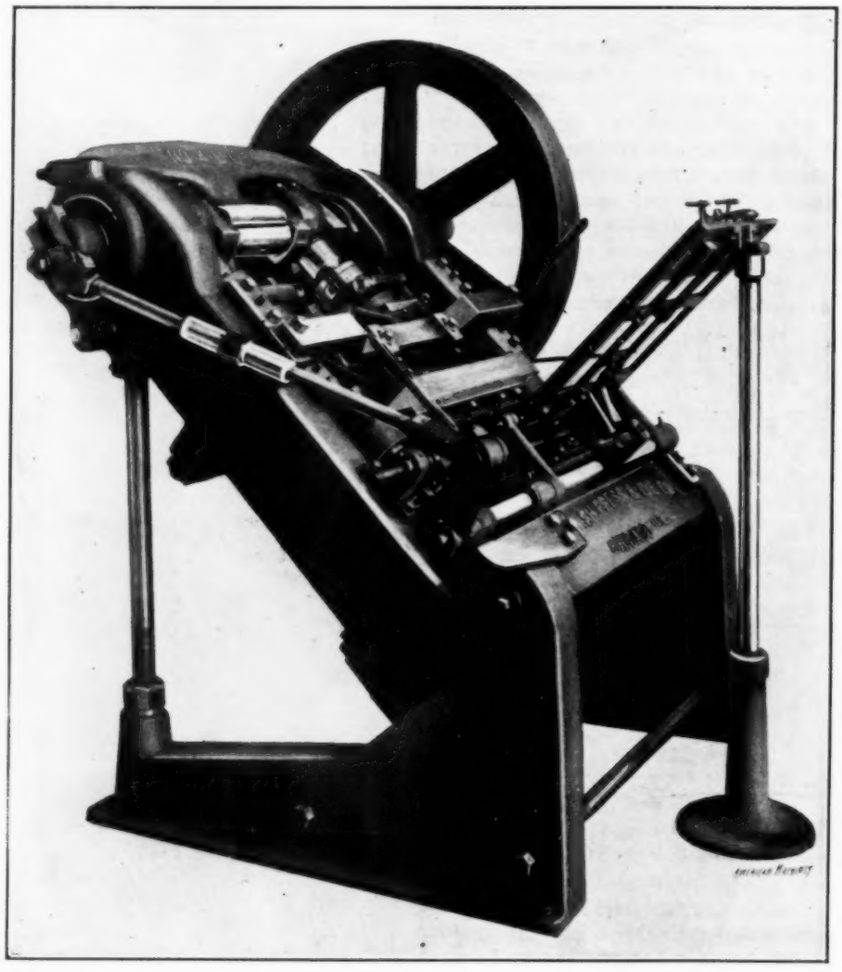
The Montgomery Chemical Works of Rockville, Md., have placed on the market a carbonizing material that they call the Ajax compound. With this compound, steel has been carbonized 1/32 of an inch deep in about seven hours at 1650 degrees Fahrenheit and ⅛ inch

A Double Crank Power Press

The halftone shows a special press and equipment built by the Walsh Press and Die Company, Chicago, Ill.

The press is swung on trunnions in front and is supported at the back by two vertical jack screws. By this means it is easily adjusted to the most convenient angle to suit the requirements of the work to be done.

The press shown is fitted with a gang of eight dies and an automatic feed for the rapid production of drawn shells 2⅛ inches in diameter by ¾ inch deep. The machine cuts and draws eight shells each stroke and runs at a speed of 90 strokes per minute. Each sheet of tin, 20x28 inches, furnishes 80 blanks. The feed to the dies is entirely automatic, the operator inserting a fresh sheet when the previous one has been used up.



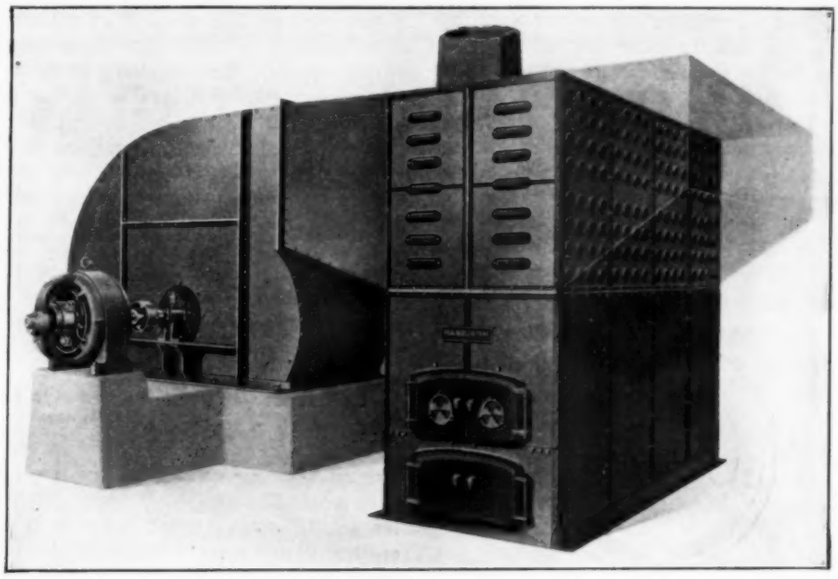
A Double-crank Power Press

in depth has been obtained in ten hours at 1800 degrees Fahrenheit.

The Harrison Aertube Heater

The halftone shows a motor-driven fan and Aertube heater built by the Harrison Engineering Company, New York.

Aertube plant consists of a furnace under a bank of horizontal tubes through which the air to be heated is driven by a fan; and the distribution ducts.



THE HARRISON AERTUBE HEATER

The heat from the fire strikes directly on the heating tubes, and is distributed among them by baffle plates. The transfer of the heat of the furnace to the air passing through the tubes is direct and immediate.

While the Harrison system is applicable in any type of building, it is especially satisfactory where the heating system must also provide mechanical ventilation, and is particularly adapted to buildings which do not require steam for power purposes, but which have electric or other power.

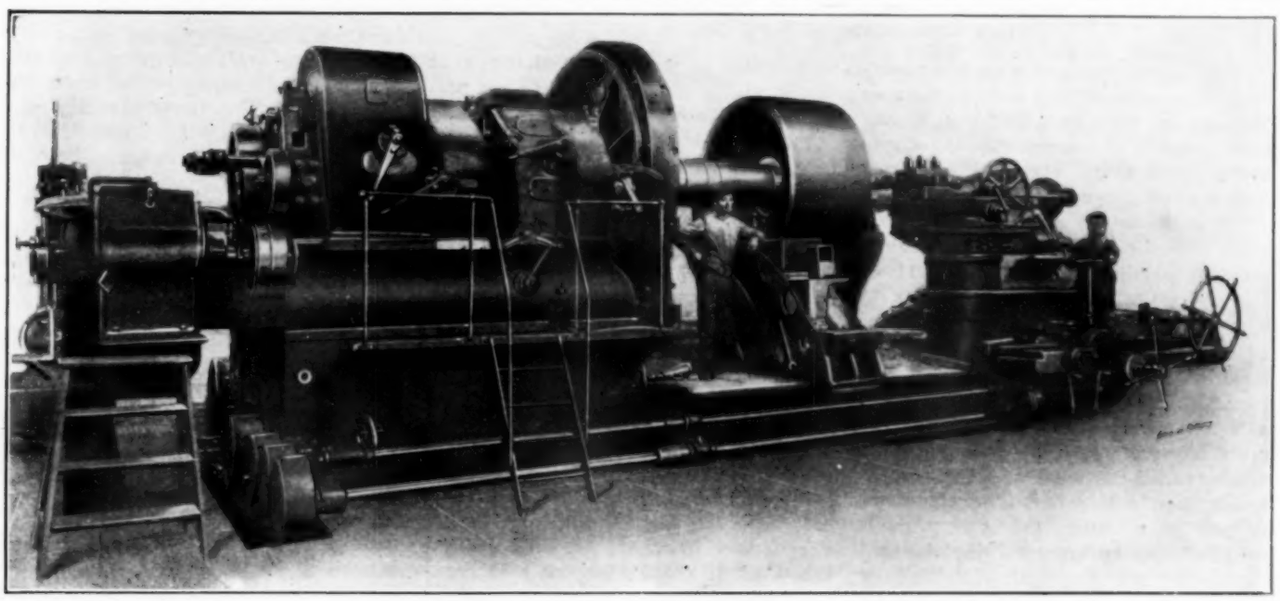
A Lathe for Turning Turbine Shafts

This machine, built by Ernest Schiess, Werkzeugmaschinenfabrik, A. G., Düsseldorf, Germany, is intended for work up to 50,000 kilograms (105,000 pounds) in weight. Its centers are 1650 millimeters high (132 inches swing) and will take work 9000 millimeters long (30 feet). The length of the bed is 14,700 millimeters (45 feet 8 inches). Its width, 3700 millimeters (12 feet 4 inches) with a swing over the carriage of 3000 millimeters (120 inches). The machine is designed to use high-speed steel to its fullest capacity. The face plate is 2500 millimeters (100 inches) diameter and is provided with four face-plate jaws. The live spindle runs in adjustable cylindrical bronze boxes. It is driven by an electric motor of 35 horsepower, which runs at a constant speed of about 650 revolutions per minute.

Through gearing, which is easily manipulated by hand lever, twenty different speeds of the main spindle, between the limits of 0.5 and 100 revolutions per minute are obtained. A slip coupling is attached to the motor as a safeguard against overload of the drive. The bed is flat on top, with two bearing surfaces, one at the front and one at the back, each of which is provided with a separate carriage. The two carriages have both hand feed and power feed, by means of the splined shaft. The cross feed is by screw. The carriages have also a rapid traverse by power.

The tailstock is moved along the bed by gearing on the front; it can also be set over. A cast-iron ratchet rack prevents the tailstock from moving when once set. The adjustment of the tail spindle is from the front side of the tailstock. All wheels, handles and levers for changing and reversing the feed are mounted on the carriages themselves. All gears in the carriage and in the spindle casing and carriages, as well as the rack on the bed for the movement of the carriages, are of steel; the teeth being milled or planed. The machine complete weighs 95,000 kilograms—about 199,500 pounds.

According to a contemporary, compressed air for signaling from the bottom of shafts to the hoisting engine-room at the surface is used at the Moodna pressure tunnel, of the Catskill aqueduct.



A LATHE FOR TURNING TURBINE SHAFTS

Experience with Rocking Couple

By F. W. Birks

Some few years ago, while acting as engineer for a sawmill on the banks of the River Plate, a curious incident came under my notice. The machinery of the mill had been made by one of the best known builders of this class of machinery in England, the particular one whose peculiar actions I am about to describe being a single-bladed horizontal saw used for cutting logs of hard native timber, viz, *cuebracho colarado* and *blanco* into planks. The saw frame was reciprocated between guides, by a connecting rod coupled to the crank shown in Fig. 1, the latter being fitted with two wheels acting in the combined capacities of flywheels and pulleys. Power was transmitted by a belt on each wheel. As is indicated in the sketch, the rims of each wheel were cored out so as to accurately balance the crank and half the weight of the rod.

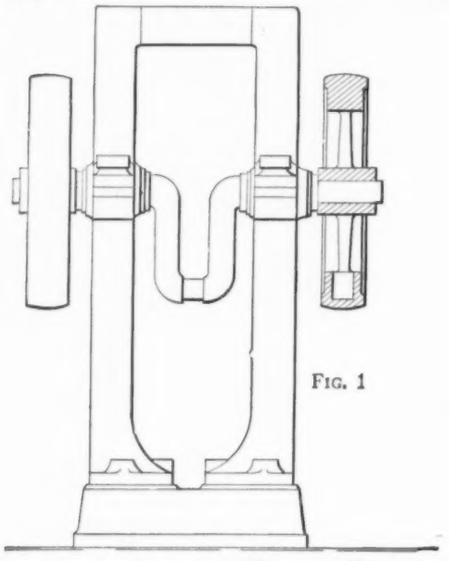


FIG. 1

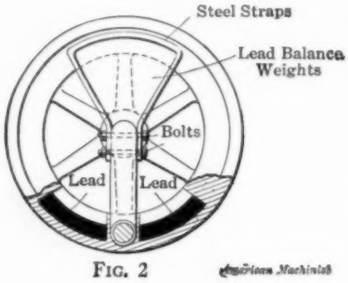


FIG. 2

HOW THE BALANCING WAS DONE

Immediately on starting up after erection, the crank was seen to be running so badly out of truth that the whole framework of the machine was positively writhing and would assuredly have collapsed after a run of an hour or so.

The usual casual amateur experts, always greatly to the fore in any Spanish-speaking country, at once lit cigarettes and cheerfully pronounced the crank to have been bent in transit, the fallacy of which was easily proved by means of a scriber, when the machine was turned round by hand.

We then went carefully all round, seeing that everything was perfectly in line and rebedded the brasses, all to no purpose. Then in desperation, the crank was swung in a lathe and the journals shimmed up, the brasses being replaced by running in white metal. This time we ran until the bearings were shrieking hot and the metal began to run.

Being young at the time, and by no means bowed down by either the weight of years or experience, I was almost inclined to accept the theory of the half-breed mechanics there, that the thing, well garnished by sundry, searching oaths, was a habitation of the Evil One. Suddenly it dawned upon me that the trouble was due to a rocking couple set up when running at full speed, 220 revolutions per minute, due to the crank being light and the balance weights not being in the same plane as the mass they were balancing.

There being a quantity of scrap lead on the spot, we ran an amount into the holes in the rim of the wheels equal in weight to that of the cast iron required to fill them, while accurate leaden balance weights were prepared and fixed to the crank by means of steel straps, as shown on Fig. 2. The saw has run perfectly ever since.

Now the extraordinary thing is, that on writing and explaining as above to the makers, they stated that the machine was a standard one, that a number had previously been made, and that hitherto no such trouble had been experienced.

Look After the Shop Vises

Recently one man quit a job he had partly completed and left his work to take up another job for the purpose of letting another man use the vise at which he had been working. There was a shortage of vises in the shop, and upon investigation, it was found that a good deal of that kind of shifting around was regularly done by the workmen. It would be interesting to figure out exactly the cost of such shifting, and it is evident that the yearly cost thereof would considerably more than pay for two or three vises.

While thinking about the effect of a scarcity of vises, it was noticed that some of the vises in use were in very poor condition, and that there was so much lost motion between the screw and nut that the workmen had to turn the handle one or more full turns before the traveling jaw would take hold of the work. It is not much of a task to turn a vise lever a turn or two, but when it is repeated every minute, or once each two minutes during the day, the time thus consumed will amount to a considerable number of minutes.

The trouble with the "time-killing vise" is not in one place, but is a combination of several things which are not right. The total lost motion in a vise is, say, 1¼ turns of the screw. A part of this is in the nut, which has worn considerably. Some more of the lost motion is in the looseness of the nut which moves back and forth nearly 1/16 inch in its mortise in the vise casting.

The balance of the lost motion is in the collar which takes the strain when the vise jaw is moved back. The fixed collars on both the screw and vise casting have worn, likewise the loose or set-collar on the screw, hence there is play enough at this point to make up the 1¼ turns of lost motion above noted. All this lost motion could be easily taken up, excepting that in the nut, which is so small as to be negligible were the rest of it removed.

Lubricating Hot Rolls

A certain manufacturer had an order for a machine that included three hollow gun-metal rollers. These rollers are heated by gas to a temperature of about 700 degrees and it was found that any oil or grease would carbonize and cut the journals in a very short while. Dixon's flake graphite was then tried with excellent results.

The method of applying the graphite to the journals is very simple; the channels for conveying the lubricant to the journals are cut in the boxes about ⅜ inch wide and ¼ inch deep, one on top and one at a little above and on each quarter. Besides this, a spiral groove of the same dimensions is cut for about two turns, commencing at about 1 inch from the other end of the box and near the bottom. The journals take about a dessertspoonful of graphite per day to each journal, the machine attendant occasionally removing the cap from the cup, churning down a little of the graphite with the 3/16-inch rod.

Face-Plate Chucking

Why it is, is very hard to determine, but it is a fact that nearly every machinist when chucking, on the jaw chuck, some article to be bored will almost invariably place the article bang-up against the faceplate of the chuck and then when the tool passes through, it takes a bite or two out of the chuck. Every cub has been told and told, time and again, not to chuck work close to the plate, but they still put it there and the journeymen machinists do the same trick time after time, when they could just as well place the work an inch or more out from the chuck and save the plate from tool damage.

Only the most energetic vigilance on the part of a foreman can rid the shop of this chuck-damaging habit, and even then, the habit comes out like pulling teeth. A system of fines and penalties, rigidly adhered to and enforced might help matters in this direction and the making of a set of distance rings by the shop, would help a good deal. A set of cast-iron rings or cylinders, of inch lengths, and of varying diameters, will be found very handy additions to the chucking lathe. By the use of one or more of these rings, any article may be backed up against the ring, the same as it would be backed against the chuck-plate. In large work, where chucking at a distance from the plate is necessary, these rings form excellent distance pieces, and the insertion of a single bolt, loosely, in each ring, will prevent them from falling out if they chance to get loose. Thus rings are much easier held than rectangular distance pieces when they become loosened.

Increasing Shop Capacities

Metal Working

George Nelson will erect a blacksmith shop at Franklin, Minn.

Case Cutlery Company, Smethport, Penn., contemplates an addition.

Boeg & Beck are building an addition to their plant in Moline, Ill.

Sharon Foundry Company, Sharon, Penn., is building a large addition.

The Auto Truck Company, Detroit, Mich., will soon erect a new plant.

The Corry Metal Furniture Company, Corry, Penn., will build a new factory.

The Seitz Motor Company, Wyandotte, Detroit, Mich., is to build a new factory.

McLaughlin Carriage and Auto Company, Oshawa, Can., are building a large factory.

The Bell Engine and Thresher Company, Seaforth, Ont., will largely increase its plant.

The C. W. Kelsey Company, Hartford, Conn., is soon to start the manufacture of motorettes.

The Link-Belt Company, Chicago, Ill., is erecting a new factory building at Stockton.

The Seneca Chain Company, Kent, Ohio, is planning the erection of two new buildings.

The Ingram-Richardson Company, Beaver Falls, Penn., is building a two-story addition.

The Dominion Safe and Vault Company, Farnham, Quebec, are building a large factory.

The International Harvester Company, of Milwaukee, are to build a $400,000 plant at once.

Work has been started on a large addition to the plant of Potter & Johnston, Pawtucket, R. I.

Superior Drop Forge and Manufacturing Company, Cleveland, O., will build a new plant.

King & Dillow, New Lexington, Ohio, are to equip a machine shop in connection with their garage.

A new plant for the Hale Machinery Company, Detroit, Mich., is soon to be constructed.

Milwaukee Machine Tool Company, Milwaukee, Wis., will build a new factory building.

Westinghouse Electric and Manufacturing Company is building a new foundry in Trafford City.

The new iron foundry of the Dent Hardware Company, Fullerton, Penn., is nearing completion.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

The Victor Safe and Lock Company, Cincinnati, Ohio, is erecting a new plant in Norwood, Ohio.

A new factory building in Sandusky, Ohio, is to be constructed by the One Minute Washer Company.

The Santa Fe Railroad has started the building of large new shops in San Bernardino, Cal.

A new $100,000 automobile plant is to be erected in St. Louis, Mo., by the Victor Automobile Company.

D. A. Sulles, Los Vegas, N. M., has commenced the construction of a new machine shop and garage.

The Zanesville (Ohio) Mould Company will increase its capacity by the addition of several machine tools.

Velie Motor Vehicle Company, Moline, Ill., is erecting a new factory for the manufacture of motors and parts.

The Missouri Pacific Railroad Company has started the construction of a new machine shop at Falls City, Kan.

Work on the new boiler and machine shops of the Jackson & Church Company, Saginaw, Mich., has been started.

The Berlin Machine Works, Beloit, Wis., contemplates the erection of a large factory in or near Seattle, Wash.

A new factory will be built for the manufacture of a new harvesting machine by Deere & Co., Moline, Ill.

Work on the erection of the new plant of the Sommer Motor Company, at Bucyrus, Ohio, is to begin at once.

The new plant of the Gardner Machine Company, South Beloit, Mich., is now in the course of construction.

Cooper Gear Works has dismantled its plant at Struthers, O., and is to operate a new plant at St. Louis, Mo.

The Atlas Foundry and Machine Company, Tacoma, Wash., will erect a machine shop and foundry; cost, $25,000.

A large tract of land has been secured for the erection of a new plant for the Elkhart Brass Company, Elkhart, Ind.

The Aluminum Company of America, New Kensington, Penn., has let contract for the erection of two new buildings.

E. H. Harriman estate will erect an electric-light plant, planing mill, blacksmith and machine shops at Turner, N. Y.

The Union Twist Drill Company, Athol, Mass., is building additions to its plant and will require new machine tools.

A new machine shop and foundry is to be constructed for the Atlas Foundry and Machine Company, Tacoma, Wash.

The Berlin Machine Works, Beloit, Wis., has under consideration the erection of a $600,000 plant at Seattle, Wash.

The Maritime Edge Tool Company is building a large addition to its works at St. Stephen, New Brunswick, Canada.

The George Whiting Company, Chicago, Ill., manufacturer of punches and shears, is to build a $30,000 machine shop.

The Koehring Machine Company, Milwaukee, Wis., has increased its capital stock for the purpose of extending its factory.

The Racine Tool and Machine Company, Racine, Wis., will build a new machine shop and will require additional machinery.

The F. I. A. T. Company has taken deed to land in Poughkeepsie, N. Y., on which it expects to build an automobile factory.

The Maxwell-Briscoe Motor Company, Newcastle, Ind., is considering plans for the further extension of its plant located here.

The Wortman & Ward Company, London, Ont., manufacturers of pumps and churns, will build a large branch factory at Winnipeg.

Barnard & Leas Manufacturing Company, Moline, Ill., is adding to its machine equipment and additions to its factory buildings.

The Brodesser Motor Truck Company, Milwaukee, Wis., has bought land in Juneau, Wis., on which it will build an auxiliary factory.

Toms & Blair, San Diego, Cal., sheet manufacturers, are equipping their plant for the manufacture of a recently invented inclined-gravity hinge.

The Missouri Pacific Railroad Company is to build a large machine and repair shop in Kansas City, Mo., to be ready for occupancy by May 1, 1911.

The Webster & Perks Tool Company, Springfield, Ohio, contemplate in the not distant future the erection of a new factory to be completely equipped.

Domestic Manufacturing Company, Racine, Wis., is to engage in the manufacture of automobile-steering gears for which it will be in the market for machine tools.

The C. O. Bartlett & Snow Company, Cleveland, Ohio, manufacturer of elevating and conveying machinery, has leased an additional plant and will install new equipment.

The International Harvester Company, Chatham, Ont., Canada, has acquired control of the Chatham Wagon Company. Extensive additions to the present plant will follow.

Large shops for building steel passenger cars are to be built by Charles Schwab, of Bethlehem Steel Company, at Wilmington, Del., at the Harlan & Hollingsworth works.

The Baldwin Forging and Tool Company, Columbus, Ohio, manufacturer of shovels, spades and scoops, is to remove to Parkersburg, W. Va., where it will erect a $300,000 plant.

The plant of the Bradford Car and Manufacturing Company, Bradford, Ill., has been leased to Joseph Cody & Sons, Peoria, Ill., who are engaged in the manufacture of boilers.

C. S. Workinger, formerly of the Sibley Machine Tool Company, and O. G. Kibbve, of Elkhart, Ind., have formed a partnership and purchased the plant of the Edward Kelley Foundry Company, Elkhart, Ind.

General Manufacturing

A new municipal light plant is to be built at Hudson, Ohio.

Aylmer, Ont., will spend $25,000 for new waterworks machinery.

Collingwood, Ont., will spend $25,000 for new waterworks machinery.

The National Condensing Company will erect a plant at Manawa, Wis.

The Rutland Railroad Company is to build a roundhouse at Bennington, Vt.

Esteran, Saskatchewan, Canada, will install a complete electric-lighting plant.

C. L. Werry & Son have established an automobile factory in Norwalk, Ohio.

Camrose, Alberta, Can., will spend $30,000 for new electric-lighting apparatus.

The Liquid Carbonic Company is building a new factory in Cambridge, Mass.

The Hercules Buggy Company, Evansville, Ind., contemplates a large addition.

Penetanguishene, Ont., intends to purchase water meters to the extent of $3500.

The London Gas Power Company, London, Canada, is building a large new factory.

New electrical pumping machinery is to be installed by the city of London, Canada.

The Berliner Gramophone Company is building large shops at Montreal, Canada.

British Columbia Piano Company will locate a large factory at Vancouver, B. C.

A large addition is being made to the Spare Wheel Company's plant, in Kankakee, Ill.

The Wausau Sulphate Fibre Company, Wausau, Wis., has decided to build a paper mill.

The Winnebago Brick and Tile Company will erect a large plant at Winnebago, Minn.

Boucher & Co., Farnham, Quebec., are building a large new sash and door factory.

The Yreka (Cal.) Railroad Company has begun breaking ground for a new roundhouse.

Lethbridge, Alberta, Can., is in the market for $12,000 worth of steam shovels and equipment.

The Consumers Ice and Coal Company, Ocean Grove, N. J., is to enlarge its power plant.

The Cream City Casket Company, Milwaukee, Wis., will erect an addition to its plant.

The John Schroeder Luncher Company, Milwaukee, Wis., will erect an addition to its plant.

The Ottawa Electric Company, Ottawa, Can., will equip a large new transformer station.

William Neilson Company, of Toronto, Can., is building large additions to its furniture factory.

The Worcester Electric Light Company, Worcester, Mass., will erect a new power station.

The contract for the erection of the Northwestern Power House, Freeport, Ill., has been awarded.

The Jersey Central Railroad Company has started work on a new roundhouse in Bellevue, Penn.

The Co-Operative Condensed Milk Company is erecting a factory at Fort Covington, N. Y.

The Wildermuth Bending Company, Columbus, Ohio, will erect three branch mills in Columbus, Wis.

Millville Gas and Light Company are to increase the capacity of the power plant in Millville, N. J.

Voss Brothers Manufacturing Company, Davenport, Iowa, has let contract for a new factory building.

Franklin Consolidated Mines Company, Victoria, B. C., is to install considerable new mining machinery.

New waterworks machinery to the extent of $50,000, is to be purchased by Medicine Hat, Alberta, Can.

Dominion Dry Dock Company, Montreal, Canada, will build a large ship-repairing plant at St. John, N. B.

Otto Higel Company, Toronto, Can., manufacturer of piano parts, is building large additions to its plant.

The Seneca Chair Company, Kent, Ohio, contemplates considerably increasing its capacity for output.

Inland Coal and Coke Company, B. C., will spend $1,500,000 developing coalfields and establishing sawmills.

Fort George Water and Light Company, Fort George, B. C., will equip a plant for supplying power and light.

The Barlow-Kent Furniture Company, Urbana, Ohio, will soon start the erection of a large addition to its factory.

The American Viscose Company, Chester, Penn., is to build a factory for the manufacture of artificial silk from wood pulp.

The Nebraska Buick Company, Lincoln, Neb., is considering the erection of a branch automobile plant in the Lincoln section.

The Metals Welding Company has taken a lease on property in Cleveland, Ohio, and will immediately start the erection of a plant.

The Dugger & Gashorn Company, Memphis, Tenn., is to engage in the manufacture of plow handles, beams, rounds, wagon stock, etc.

At Urichsville, Ohio, the Big Stillwater Sewer Pipe Company has completed arrangements for the erection of a large sewer-pipe plant.

A new power-house building, in Toledo, Ohio, is to be constructed. The Macomber Brothers Company is interested in the enterprise.

The Ashland Power Company has been awarded a franchise to install a light, power and heating plant, also street-car system, in Ironwood, Mich.

The Farmers Union, H. H. McLean, president, will erect a flour mill at Walla Walla, and Adams, Wash., as well as a power plant; total cost, $400,000.

It is stated that plans are under way for the removal of the plant of the Damascus Brake Beam Company, Sharon, Penn., which was recently destroyed by fire.

Ground was broken by the contractors for the erection of a large new brick and steel boiler shop for the Southern Railway Company, at Spencer, N. C.

W. W. Wunder, manufacturer of fire apparatus, Reading, Penn., is interested in the erection of a large plant for the manufacture of combination chemical and fire engine.

John B. Crosby Company, of Halifax, Eng., has purchased the Mammoth Carpet Mills, Matteawan, and Fishkill Landing, N. Y., and will resume operation of the plants, installing new machinery.

The Sheboygan Light, Power and Railway Company, Sheboygan, Wis., has let contracts for improvements aggregating $100,000, including steel and brick car barn and new steam turbines.

The Isthmian Canal Commission, Washington, D. C., will open on August 19, under circular No. 598, bids for steel castings, manganese-steel bushings, steel, iron, brass condenser tubes, cast-iron pipe, sluice gate, valves, pumps, etc.

Robert Grimshaw, Dresden A., Johannstadler, Ufer, 3, Germany, reports in behalf of a German concern, a market for 15,000 to 20,000 water meters, and desires prices of various sizes, c. i. f., Bremen or Hamburg.

Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will open bids on August 16, for the followng: Blocks, chain, differential (schedule 2777); bolts, nuts, etc. (schedule 2773); lathes, gear-cutting machines, screw machine (schedules 2764 and 2765); metals of various kinds (schedules 2773, 2776, 2770, 2779); pipe, pipe fittings, valves, tubing, etc. (schedule 2779). Bids opening on August 23, as follows: Pipe, fittings, coverings (schedule 2769); bolts and nuts (schedule 2785); hardware (schedule 2784); steel (schedule 2785).

Fires

Sowlitz Shingle Company, Castlerock, Wash., destroyed. Loss, $20,000.

Warner Pole & Tap Company, Cincinnati, Ohio, destroyed. Loss, $40,000.

The city electric light and water plant at McPherson, Kan., was destroyed by fire.

Entire plant of the Zanesville (Ohio) Art Pottery Company was destroyed by fire.

Cincinnati Ball Crank Company, Cincinnati, Ohio, destroyed by fire. Loss, $60,000.

E. H. Heap Lumber Mill, Ruskin, B. C., completely destroyed by fire. Loss, $50,000.

Fire destroyed the carriage factory of A. Schultz, Pompton Plains, N. J. Loss, $4000.

P. McLaren's Lumber Mill, Blairmore, B. C., was completely destroyed by fire. Loss, $50,000.

Factory of the Campbell Stuart Chair Company, Princeton, Mass., was destroyed. Loss, $20,000.

Fire destroyed the main building of the Monarch Iron Works, Plymouth, Ind. Loss, $10,000.

Fire totally destroyed the shops of the Carolina & Northwestern Railway, located at Chester, S. C.

The mills of the Buchanan & Swoch Lumber Company, Asbury Park, N. J., were destroyed. Loss, $150,000.

Part of the furniture plant of John J. Reifsnyder, Philadelphia, Penn., was destroyed by fire.

Part of the Neeley Nut and Bolt Company plant, Pittsburg, Penn., was destroyed by fire. Loss, $25,000.

Plant of the Consolidated Lamp and Glass Company, Coraopolis, Penn., was destroyed by fire. Loss, $60,000.

Germantown Tool Works, Germantown, Penn., was destroyed by fire and will move into its new factory just completed.

Fire destroyed the Thomas Brass and Iron Company and the Durand Steel Locker Company, Belvidere, Ill. Loss, $250,000.

Durand Steel Lacquer Company, Waukegan, Ill., and Thomas Brass and Iron Company, of the same place, were destroyed by fire. Loss, $350,000.

The Norfolk mills of the Cochrane Manufacturing Company, East Dedham, Mass., was damaged by fire. Dynamos and manufacturing machinery destroyed to extent of $40,000.

NEW INCORPORATIONS

Scranton Axle and Spring Company, Scranton, Penn. Capital, $125,000.

Art Hardware and Manufacturing Company, Seattle. Capital, $50,000. W. C. Hendricks, J. Von Herberg.

Federal Motor Company. Capital, $400,000. Incorporators, A. Smith, G. W. May, G. W. Dorsey, Jr., Wilmington.

The Chickamauga Steel Company, incorporated at Trenton, N. J. Capital, $5,000,000. Principal office in Jersey City.

Milwaukee Structural Steel Company, Milwaukee, Wis., $25,000. V. M. Witmer, W. J. Pfannenstill and C. W. Jostin.

Del Manufacturing Company, Chicago, Ill. $2500. Machinery. Irving J. Solomon, Francis E. Matthews, Elmer Schlesinger.

Spokane Oxy-Acetylene Welding Company, Spokane, Wash. Capital, $20,000. E. T. Richter, O. E. Logan, R. H. Raines.

F. R. Parker Company, Boston. Automobiles. Capital, $50,000. President, F. R. Parker; treasurer, C. C. Colby, Boston.

Carson Garage and Auto Company, Peru, Ind. $15,000. V. E. Carson, E. E. Connor, Maggie E. Carson and Margaret Connor.

The United States Iron and Steel Company of Texas, Houston. Capital stock, $150,000. Incorporators, N. L. Mills, J. W. Barnes, J. B. Hine.

Package Machine Company, Indianapolis, Ind. $25,000 to manufacture veneer barrels. C. E. Gregory, F. B. Davenport and J. R. C. Marsh.

The Grath Motor Car Company, Cleveland. Capital, $400,000. George S. Patterson, H. A. Stahl, E. J. Thobaben, F. C. Carroll, C. P. Colley.

Crane Credit Register Company, Lafayette, Ind. Capital, $10,000. Incorporators, S. W. Crane, B. F. Hoffman, F. H. Crane and Ruth Hoffman.

Premier Engineering and Manufacturing Company. Capital, $100,000. Incorporators, E. J. Forhan, G. F. Martin, H. P. Jones, New York City.

Atlantic Coast Hardware Company, Boston, Mass. Hardware. Capital, $50,000. President, J. B. Hunter; treasurer, H. W. Sanders, Boston.

The Peerless Brass Manufacturing Company, Cleveland, Ohio. Capital, $20,000. J. F. Zedlicka, Carl Zedlicka, Anton Zedlicka, P. J. Brady and J. J. Gaughan.

Webster & Perks Tool Company, Springfield, Ohio. Capital stock, $25,000. Incorporators, Herman Voges, Jr., G. W. Perks, A. W. Perks, R. C. Mitchell.

H. G. Lipscomb & Co., Nashville, Tenn. Capital, $300,000. Hardware manufacturing. Incorporators, H. G. Lipscomb, H. Z. Lipscomb, and Houston Lipscomb.

United Cash Register Company, New York, N. Y. Manufacture cash registers, adding machines. Capital, $100,000. Incorporators, W. D. McCoy, J. Winter and others.

The United States Iron and Steel Company of Texas, of Houston. Capital stock, $150,000. Incorporators, N. L. Mills, J. W. Bernes, J. W. Barnes and J. B. Hine.

Victor Motor Car Company, incorporated at Trenton, N. J. Manufacture and deal in automobiles. Capital, $150,000. Incorporators, J. H. Harrington, and J. F. Harrington.

Cab and Taxi Company of New York, Millbroo. Livery and motor-car service. Capital, $2,500,000. Incorporators, T. Faber, J. J. Sullivan, H. E. Von Pein, New York City.

Rochester Trolley Guard and Finder Company, Rochester, N. Y. Capital, $50,000. Directors, William F. Reichenbach, Alois A. Piehler, Charles W. Henning, all of Rochester.

Port Jackson Engineering and Manufacturing Company, Amsterdam, N. Y. Capital, $25,000. Incorporators, R. G. Daye, E. Jackson, Amsterdam; C. H. Williams, Rotterdam.

Ethylight Company, Manhattan. Manufacture automobile lamps and lighting devices. Capital, $350,000. Incorporators, R. E. Taylor, R. C. Shaal, J. V. Usera, New York City.

Crucible Steel Castings Company, Cleveland, $25,000, to make steel articles of all kinds. William Schnell, A. H. Kaufman, H. L. Aiken, Charles W. Kaufman and William H. Aiken.

The Cairo Drilling Company, Cairo, W. Va. Capital, $10,000. Incorporators, George Rinehart, H. N. Rinehart, W. H. Moyers, John Leeton and C. F. Vincent, all of Cairo, W. Va.

J. S. Stevens Auto Company, Cincinnati, $5000, to do a general automobile and garage business. J. F. Turner, J. K. Gilchrist, J. S. Stevens, F. G. Stevens and Stephen R. Hollen.

Reserve Electrical Company, Cleveland, $10,000, to manufacture electrical equipment of all kinds. W. F. Brooks, H. Craig, C. Raber, William J. Wilson and R. M. Zimmerman.

Cochran Pipe Wrench Manufacturing Company, Chicago, Ill. Manufacture machinery, tools and engines. Capital, $100,000. Incorporators, F. E. Hinckley, J. M. Cochran, W. W. Taylor.

Lockwood Piano Company, New York. Manufacture pianos, organs and other musical instruments. Capital, $15,000. Incorporators: George E. Jacobi, Alonzo Alger, Harry M. Hyer.

Kasper & Koetzle, Brooklyn, N. Y. Manufacture and deal in iron, steel, manganese, copper, etc. Capital, $30,000. Incorporators, W. Kasper, F. Koetzle, L. J. Kasper, Brooklyn, N. Y.

Taylor Brothers & Co., Fulton, N. Y. Manufacture and deal in paper machinery and supplies. Capital, $40,000. Incorporators, C. C. Benedict, J. A. Benedict, T. A. Benedict, Fulton.

St. Paul Independent Automobile Garage Company, St. Paul, Minn. $100,000. Manufacturing auto devices, supplies, etc. John A. Hedlund, Lewis Lee, William A. Bergen and Matt Schanno.

Stephens-Cropley Company, Chicago. Manufacture and deal in vehicles, engines, machinery, etc. Capital, $25,000. Incorporators, George W. Stephens, Fred S. Cropley, William A. Conover.

The Main Electric Company, Manhattan. Manufacture and deal in lamps and appliances for light or heat. Capital, $50,000. Incorporators, S. White, E. Braun, H. Huennekes, New York City.

Humboldt Garage Company, Buffalo, N. Y. Build and operate garages, etc. Capital, $1000. Incorporators, Chas. E. Congdon, Chas. J. Rosengren, Wm. H. Woodbury, Henry J. Siedler, all of Buffalo, N. Y.

Newark Machine Company, 57 Lafayette place, Newark, N. J. General machine shop. Capital, $50,000. Incorporators, Joseph H. Gay, East Orange, N. J.; Herbert S. Gay and Charles P. Day, both of Newark, N. J.

Union Arms Company, Toledo, Ohio, $100,000, to manufacture and sell all kinds of fire arms and appliances. Frank W. Coughling, Frank E. Miller, Charles Weinrich, Harry W. Isenberg and Eugene H. Winkworth.

Fiber Products Company, Elyria, Lorain county, Ohio, $10,000, to manufacture and sell automobile and motorcycle supplies of all kinds. H. L. Dunham, I. D. Faxton, 2d, George McIntyre, J. R. Giebel and E. M. Sheanan.

American Shop Equipment Company, at Portland, Me., for manufacturing and dealing in all kinds of railroad and shop supplies. Capital stock, $300,000. President, Clarence E. Eaton; treasurer, Albert F. Jones, both of Portland.

The American Electric and Manufacturing Company, at Hallowell, Me., for conducting a general manufacturing business. Capital stock, $600 paid in. President, G. W. Boynton, Waterville; treasurer, C. H. O'Brien, Hallowell.

Perfection Manufacturing Company, Columbus, Ohio, $25,000, to manufacture and sell machinery, tools, implements and the products of machines. L. P. Stephens, George W. Campbell, Barton Griffith, F. H. Heywood and O. P. Cockrill.

DeLuxe Motor Vehicle Company, Cleveland, $100,000, to manufacture and sell motor vehicles, automobiles, motor cycles and accessories of all kinds. W. G. Moore, William P. Wynn, R. M. Darrance, George A. Gaston and M. L. Thompson.

Bessler Movable Stairway Company, Akron, $50,000, to manufacture and sell a movable stairway, after patents which have been granted. Carvil C. Bessler, Frank E. Bessler, Joseph F. Sauvee, Hohn F. Brouse and Edwin W. Brouse.

Port Chester Machine Works, Inc., Port Chester, N. Y. Manufacture machinery. Capital, $9000. Incorporators, Frederick Steinmetz, Port Chester, N. Y.; George V. Steinmetz, Bridgeport, Conn.; William Steinmetz, Port Chester, N. Y.

Kingslee Piano Company, New York. Manufacture pianos, piano players and other musical instruments, etc. Capital, $1000. Incorporators, Henry Lindeman, Samuel Lindeman, James S. Holmes, Jr., Benjamin H. Stern, all of New York City.

H. F. M. Manufacturing Company, Akron, Ohio, $25,000, to manufacture and sell oil filters, exhaust heads, engine shields, oilers and other articles. C. H. Maranville, C. S. Pelton, C. E. Maranville, J. Dwight Palmer and F. C. Whittmore.

Positive Spark Plug Company, Mineola, Nassau county, New York. Manufacture and sell machinery, etc. Capital, $15,000. In-

corporators, Mortimer McKenzie, Paul Weidmann, both of Mineola, N. Y.; James C. Mceachen, Rockville Centre, N. Y.

Star Electric Company, Binghamton, N. Y. Manufacture electric supplies and appliances. Capital, $300,000. Incorporators, George O. Knapp, 54 Wall street; Giles W. Mead, Edgar F. Price, both of 79 Wall street, all of New York City, and two others.

Hempstead Aeroplane Company, Hempstead, Nassau county, New York. Manufacture, deal in and exhibit aëroplanes, etc. Capital, $3000. Incorporators, Howard J. Dietz, Stella F. Dietz, both of Hempstead, L. I., N. Y.; George Thoms, 2 Rector street, New York City.

The American Machine and Crown Company was chartered at Wilmington, Del., to manufacture, buy, sell and deal in machines for making metallic caps for bottles. The incorporators are Wilmington charter representatives, and the capital stock is $1,000,000.

The National Chamber Oven Company, of Elwood Place, near Cincinnati, has filed papers increasing its capital stock for the purpose of enlarging the facilities of the plant which is used to manufacture stoves. J. E. Stacy is president, and R. J. Turner, secretary.

Wiederhold Mantle and Burner Company, 131 Winfield avenue, Jersey City, N. J. Manufacture incandescent gas, mantles and burners, etc. Capital, $50,000. Incorporators, Charles H. Iockmus, Ansonia, Conn.; Oscar Wiederhold, Jersey City; Hugo H. Rutterbusch, New York City.

The Roanoke Copper Company, Inc., Virgilina, Va. G. R. Leghorn, president, Boston, Mass.; G. F. Tarbell, vice-president, Cambridge, Mass.; R. T. Lincoln, secretary, Lawrenceville, Mass. Capital stock, maximum, $500,000; minimum, $100,000. Objects and purposes, operate a copper mine.

American Automobile Bolier Feeder Company, at Waterville, for manufacturing and dealing in automatic boiler feeders, boilers, engines, etc. Capital, $100,000. President, George W. Boynton; treasurer, Matthew S. Goodrich, both of Waterville.

American Sandless Casting Company, to acquire certain letters patent granted to or that may be obtained by Edgar A. Custer, for casting iron in permanent metal molds. Incorporators, Frank M. Ritter, W. Northrope Cowles, of Philadelphia, and S. D. Townsend, Jr., of Wilmington. Capital stock, $5,000,000.

Saintr Valve Company, New York. Manufacture and deal in valves, machinery tools, etc. Capital, $50,000. Incorporators, Giovanni LaFrancesca, Produce Exchange building; Gennaro Romano, 597 East One Hundred and Thirty-eighth street, both of New York City; Roger Hinds, Richmond Hill, N. Y.

The Eastern Machine Screw Company, New Haven, Conn. Manufacture machine screws, screw-machine products and hardware specialties. Officers, W. S. Sippit, president; J. E. Hubinger, vice-president; W. H. Gates, vice-president and superintendent; W. S. Garde, treasurer; B. P. Greene, secretary and manager.

Business Item

The Eastern Machine Screw Company, New Haven, Conn., has been organized and incorporated under the laws of Connecticut. It is now building and equipping a new factory for the manufacture of a full line of machine screws, screw-machine products and hardware specialties. The officers of the company are Morris S. Sippitt, president; J. E. Hubinger, vice-president; Wm. H. Gates, vice-president and superintendent; Walter S. Garde, treasurer; Benjamin P. Greene, secretary and manager.

Forthcoming Meetings

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.
regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 900 G St., Washington, D. C. Write for Inventor's Handbook.

New ideas developed, designing and detailing of special machinery; terms reasonable and work strictly confidential. Box 798, AMERICAN MACHINIST.

Light, fine machinery and mechanical specialties built to order; jigs, tools, etc., designed and built. Goodson Electric and Manufacturing Co., Providence, R. I.

A well equipped machine shop within 30 miles from New York solicits orders for all kinds of machine work. Send inquiries: The Brunswick Refrigerating Co., New Brunswick, N. J.

Light or medium weight machinery to manufacture on contract or special machinery to build. Box 734, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Concern with well equipped plant for light manufacturing wants to hear from parties with established business who are desirous of enlarging their facilities, reducing their expenses for rents, etc.; plant is well located, cheap power, fuel and labor; railroad siding. Cadiz Stamping Works, Cadiz, Ohio.

First class Vienna house, dealing in machines, would accept representation of foreign machine manufacturer; only high grade articles considered; not averse to joining party should manufactory in Austria be contemplated, with a view to economize on freight and duty. Address "Fortschritt Z. 3386," Haasenstein & Vogler, A.-G., Vienna I (Austria).

Any broken machinery parts expertly welded by oxy-acetylene process; difficult repairs requiring skilful preheating are our specialty; automobile cylinders and crank cases also; ask for detailed information, references, etc.; we positively weld (not braze) cast iron, aluminum and other metals; no charge unless successful; one trial will convince you. Waterbury Welding Works, Waterbury, Conn.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Wanted — Bookkeeper for manufacturing plant, employing from 20 to 25 hands; young man familiar with modern uptodate methods, cost keeping, etc. Write fully age, experience, salary wanted. Box 812, AMER. MACHINIST

CANADA

Wanted — First-class man on automatic screw machine work, setting up, camming, devising new tools and methods speeding up; highest wages to the right man. Box 825, AMERICAN MACHINIST.

COLORADO

Due to the steady increase of our business, we are constantly in need of drill press, lathe, planer, grinder, Jones & Lamson and bench men; also toolmakers and tool smiths; good climate and location; steady work, good pay to first-class men; shop clean, light and well ventilated; 9 hours work. Address, stating experience. J. Geo. Leyner Engineering Works Co., Littleton, Colo.

CONNECTICUT

Wanted—We want a machine salesman to cover territory in and around New York City; standard machine that is used in all factories. Address P. O. Box 685, Waterbury, Conn.

Wanted—A first-class tool designer on automobile work ,one who has had experience in this class of work preferred; state experience and salary expected. The Columbia Motor Car Company, Hartford, Conn.

Wanted—Salesmen to handle on a generous commission basis, a well advertised and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

ILLINOIS

Wanted—Operators on Gleason bevel gear and Bilgram gear planers, Middle West. Address with particulars, Box 829, AM. MACH.

INDIANA

Wanted—A-1 man for tempering tools; one who has experience in case-hardening preferred; give experience and references. Address "A. B. C.," Box 186, Indianapolis, Ind.

Wanted—Working foreman, also inspector for assembling department on high-grade integrating wattmeters; state age, experience, and salary desired to start with. Box 803, AMERICAN MACHINIST.

Wanted—A thoroughly capable foreman for tool room employing twenty toolmakers and machinists; must be naturally endowed with capacity to command respect of workmen and be thoroughly experienced in very accurate and exacting punch and die work. Address "A. B. C.," Box 186, Indianapolis, Indiana.

KANSAS

Wanted—Six vertical boring-mill operators on duplicate work, and a first class drill press

man on heavy work; steady employment for the right men. The Locomotive Finished Material Co., Atchison, Kans.

MICHIGAN

Machinists—Men experienced at assembling the mechanism of crane bridges. Box 183, Detroit, Mich.

NEW JERSEY

Superintendent for machine shop wanted for large works in vicinity of New York City; must have had at least five years' experience in similar position and have handled all classes of machine work. Box 795, AM. MA.

Lathe and vise hands in shop, 15 miles from New York; must be sober and steady; opportunity for advancement; state experience, references, wages and all information in first letter. Box 843, AMER. MACHINIST.

NEW YORK

Wanted—First-class machine tool salesman, one with practical experience preferred. Box 840, AMERICAN MACHINIST.

Wanted—Experienced draftsman in centrifugal pumps and engines; give references and state salary expected. Address "Pumps," AMERICAN MACHINIST.

Wanted—First-class lathe hands, planer hands, boring mill and slotter hands; also a few erectors; must be first class and accustomed to heavy work. Address P. O. Box 953, Buffalo, N. Y.

Wanted — An experienced case-hardener; one who understands the business thoroughly; good pay and steady employment; state age, experience and salary expected. Eclipse Machine Co., Elmira, N. Y.

Wanted—Experienced draftsman with experience in furnaces, structural steel, piping, etc.; small town in western New York; give full particulars and state salary required. Box 826, AMERICAN MACHINIST.

Salesmen on a generous commission basis, competent, practical tool dressers or others capable of demonstrating the merits of the most successful steel hardening solution ever sold; five years' continuous use by responsible firms vouches for its value wherever water-hardening steels are in use. Box 760, AM. M.

Assistant to sales manager; splendid opportunity for competent young man (26-30), with outside selling experience, fluent talker and A-1 correspondent; must have machinery experience and desirably a technical training; give fully experience, nationality, age, salary expected and references. "Fortunate," Box 811, AMERICAN MACHINIST.

Assistant superintendent; opportunity of life time with young growing concern manufacturing foundry equipment; prefer technical graduate (27-30), with two years' or more shop experience; to get consideration, applicants must enumerate fully experience, age, nationality, salary expected, furnish references, etc. "Exceptional," Box 810, AM. M.

OHIO

Molders wanted on light machinery in Ohio. Box 769, AMERICAN MACHINIST.

Machinists wanted on locomotive work in the Middle West. Box 770, AM. MACH.

Wanted—Machine and floor hands; good wages and steady employment. Address Box E, Alliance, Ohio.

Machinist wanted to instruct men in the use of machine tools; give age, experience. Box 771, AMERICAN MACHINIST.

Wanted—Assistant machine shop foreman by a concern manufacturing farm machinery; one who is thoroughly uptodate and can produce results. Box 830, AMERICAN MACHINIST.

Wanted—Chief draftsman to take charge of large engineering office; must have good technical and practical training, executive ability and capable of systematizing office and getting output; good opening with opportunity for advancement; state qualifications fully in writing. Box 753, AMER. MACH.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Lathe, boring mill and floor hands; good wages, steady work. The Blaisdell Machinery Company, Bradford, Penn.

Machinists—Machine operators wanted for day and night turn; plenty of work; none but sober and steady men need apply. Standard Engineering Co., Ellwood City, Penn.

Tool draftsman and designer with shop experience, desires to change; Philadelphia or vicinity. Box 839, AMERICAN MACHINIST.

Wanted—Corresponding secretary; competent to conduct general correspondence for a manufacturer of steel products; preferably an experienced man who can also prepare estimates. "Secretary," Box 841, AMER. MACH.

Wanted—By machine tool concern, building medium size metal working machinery, an expert demonstrator to go to Europe for two years; must be first-class mechanic, capable of operating machines and assisting salesmen wherever necessary; splendid opportunity for right man. Address with full particulars, etc., Box 801, AMER. MACHINIST.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Superintendent, 36, desires change; 15 years' experience in light and medium manufacturing by uptodate methods; best references. Box 824, AMERICAN MACHINIST.

ILLINOIS

Mechanical draftsman, age 33, wants position as assistant superintendent; 8 years' practical workshop experience and 9 years in drafting room (reached limit of salary), or machine tool work, shop layout, rolling mill work and special machinery, jigs, fixtures and special tools; best references and well up in workshop practice. Box 834, AMER. MACH.

MASSACHUSETTS

Industrial school instructor; machine shop practice and drawing, only high-grade schools with reasonable salary need apply. Box 833, AMERICAN MACHINIST.

Superintendent of a large manufacturing plant, with wide experience on automatic and labor saving devices, desires making a change. Box 788, AMERICAN MACHINIST.

As factory manager by man with good experience in factory organization, management, cost and factory systems, able to keep operating production expense at a minimum; would like to correspond with any company desiring a competent man who would study their interests entirely; can stand on own record and give best references as to ability; at present employed; can give satisfactory reason for changing. Box 814, AMERICAN MACHINIST.

MICHIGAN

A man who is a first-class designer of machine tools, standard or special, will be free for engagement soon; leading position preferred; correspondence invited. Box 820, AMERICAN MACHINIST.

NEW JERSEY

Master mechanic, energetic, progressive and up to date, practical toolmaker and designer, experienced on accurate and interchangeable work; now employed but wishes change; best references as to ability and integrity. Box 835, AMERICAN MACHINIST.

NEW YORK

Master mechanic wants position at a salary of $1500. Box 823, AMER. MACHINIST.

Graduate mechanical engineer, one year's shop and six years' designing experience, desires change. Box 794, AMER. MACHINIST.

Mechanical graduate, experienced, practical tool and die maker; familiar and up to date in die castings. Box 782, AMER. MACH.

Wanted—Position as general superintendent; have had large experience in designing and building gas engines. Box 797, AM. MA.

Wanted—By experienced mechanical draftsman, position with small progressive company, where there is an undoubted future. Box 837, AMERICAN MACHINIST.

Expert hardener, middle aged, executive ability, experienced in carbon and high-speed steel, carbonizing and case-hardening, A-1 references, wants position with full charge. Box 807, AMERICAN MACHINIST.

Draftsman, 9 years' experience, automatic machinery, including sugar, cotton, textile, labeling and special machinery, thoroughly familiar with shop methods, desires position where ability counts; good references. Box 844, AMERICAN MACHINIST.

OHIO

A-1 mechanic as foreman in radiator department in automobile factory; have excellent new ideas to cheapen cost of same and better quality. Box 827, AMER. MACHINIST.

As tool room foreman; A-1 mechanic, 42 years old; uptodate on tools for interchangeable parts; also expert on dies for sheet metal and drop forgings; inventive and experimental work. Box 828, AMER. MACH.

Works manager; advertiser at present in charge of large plant manufacturing heavy machinery, desires change; wants position as works manager with responsible concern; wide experience handling large plants. Box 816, AMERICAN MACHINIST.

PENNSYLVANIA

Mechanical engineer; extensive shop practice; expert on cost reduction and increase of output; uptodate in modern shop methods. Box 831, AMERICAN MACHINIST.

Technical inventor, having ability of high grade order, sound mechanical judgment and experienced in overcoming competitive patents, wishes to make a change. Box 842, AMERICAN MACHINIST.

RHODE ISLAND

General superintendent or manager of works, wants position; 12 years' mechanical and electrical experience; first-class executive and organizer; well posted on modern methods; expert designer; technical graduate with M. E. degree; references. Box 838, AM. MA.

WISCONSIN

Superintendent, have a thorough knowledge of modern machine shop, foundry and manufacturing practice; good executive, accustomed to large works. Box 808, AMER. MACHINIST.

Situation wanted with company entering manufacture of automobiles or motors; capable of purchasing and installing machinery and tools, designing tools, jigs and fixtures, and as tool-room foreman; oven ten years' practical experience; similar positions held before; at liberty October 1. Box 832, AM. M.

Position wanted as mechanical superintendent or master mechanic; am thorough mechanic and designer, have taken out patents on agricultural implements, molding machines and gas engines; made specialty of labor-saving machines and devices; at present employed, but want to change; will go any where. Box 836, AMERICAN MACHINIST.

FOR SALE

For Sale—Nearly new No. 16 oven furnace. Mr. Wales, Keene, N. H.

For Sale—Full working drawings of a three cylinder 5½"x7½", four cycle, latest improved marine engine, complete with direct driven water and oil pumps and air compressor; money maker for machine shop wanting high class engine to build. Beck & Sargent, Engineers, 152 Lake St., Chicago, Ill.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 25 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider-Ericsson Engine Co., 35 Warren St., New York.

For Sale—Machine shop, foundry, boiler, blacksmith and pattern shop and general machinery supply business; complete equipment and doing a profitable business; located in the greatest coal, metal mining and smelting, timber and farming section of Colorado; fine city, climate, water and schools; unusual opportunity for machinist and foundryman to form partnership and secure prosperous growing business, at a sacrifice; family death necessitates owner leaving. Box 800, AM. M.

Talks With Our Readers

By the Sales Manager

"HOW do you account for the success of the AMERICAN MACHINIST?"

"Why is it the leading engineering journal of the world?"

These are questions that are put up to us occasionally.

* * *

Read the first editorial that appeared in the *first issue* of the AMERICAN MACHINIST—November, 1877.

In this practical age progress is so rapid, that, to give currency to new ideas and improvements as they obtain, nearly every large class of business has its representative newspaper, or in some instances two or three acknowledged representatives, each treating wholly on topics pertaining to its specialty. There are many journals that claim recognition as exponents of machinery matters, but not one that confines itself exclusively to this important field. Recognizing the want of a live, enterprising journal to represent the machinery interest as a distinct branch of industry, we present this, our first issue of the AMERICAN MACHINIST.

With the best facilities at our command, we propose to make this the standard machinery newspaper of America, and to this end shall direct all our efforts, being convinced that the same editorial and business corps cannot manage with the highest success two or more technical journals of the same class. WE ARE NOT SPECIALLY INTERESTED IN THE SALE OF MACHINERY OR OTHER MERCHANDISE, NOR THE PROCURING OF PATENT RIGHTS, NOR HAVE WE ANY PET SCHEME TO ADVANCE OR HOBBY TO RIDE.

The present seems peculiarly a fitting period to start out upon the territory of enterprise we have chosen, for indications are strong and positive that the fog which has for four long years enveloped the commercial progress of our country is about to lift—slowly it may be, but surely. Already light begins to dawn, and the full sunshine of business prosperity will show a development of American machinery such as the world has never before witnessed. The genius that has distanced the old world in useful mechanical inventions will brighten still more under influence of auspicious times, and rapid improvements will be wrought, the adoption of which will leave far behind those who cling to old ways and processes.

To keep our readers informed as to the most important and valuable of these inventions within the scope of machinery, giving suitable illustrations of new objects and discursive reviews of the same, is one of the prime objects of the AMERICAN MACHINIST. At the same time we shall always act independently, not holding ourselves under the least obligation to give "favorable notices" of anything under review, but rather to elicit the plain truth whether it be favorable or unfavorable. Every review of a mechanical object that appears in our columns will be prepared by a thoroughly competent party after a satisfactory examination.

Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale.

* * *

Since then our business methods have constantly changed to conform with changing conditions, and sometimes we have changed our *principals*—but never the *principles* on which this business was started.

The AMERICAN MACHINIST is published primarily for the readers—the men responsible for results in machine-making plants throughout the world.

To be helpful to them, honest with them, showing them how to better their work or their conditions.

It publishes more contributed articles than all other papers in its field combined, and pays for every line it prints.

Nothing ever appears in the text that is not of sufficient general interest to warrant publication.

It is edited by men who have worked up through the shop; men who know machinery and the making of it through actual contact with its ins and outs; men who are not troubled with "seatitis," but who are traveling—on the jump—practically all the time.

* * *

Specialization has been the keynote in advertising as well as in the editorial columns.

No advertisement that is not directly in its line is ever inserted.

This makes each advertisement that *is* in the line obtain the amount of attention its size and character command.

Nothing foreign distracts the mind of the reader.

That's why it is the leading means of distribution—the market place of the machine-making industry.

Why it has more subscribers than any other technical or engineering paper on earth.

* * *

Say you saw it in the American Machinist.

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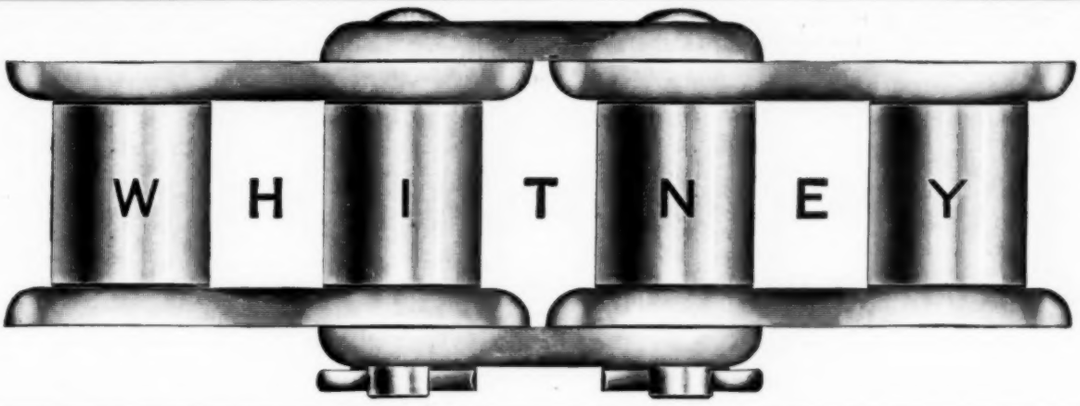

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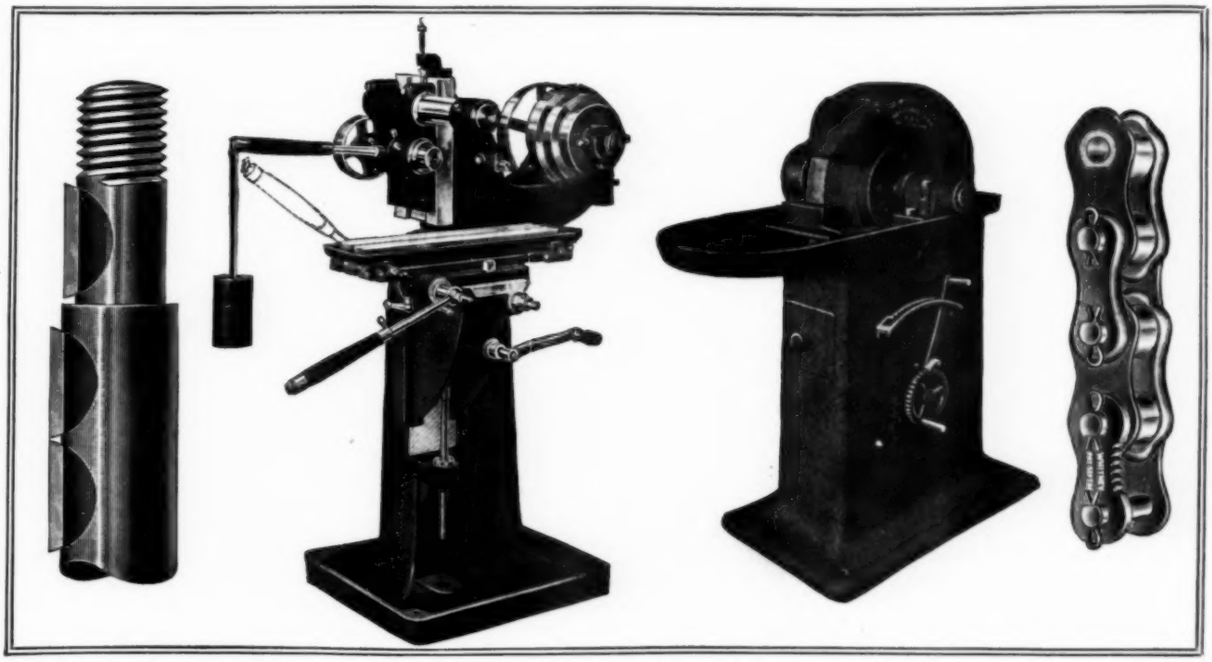

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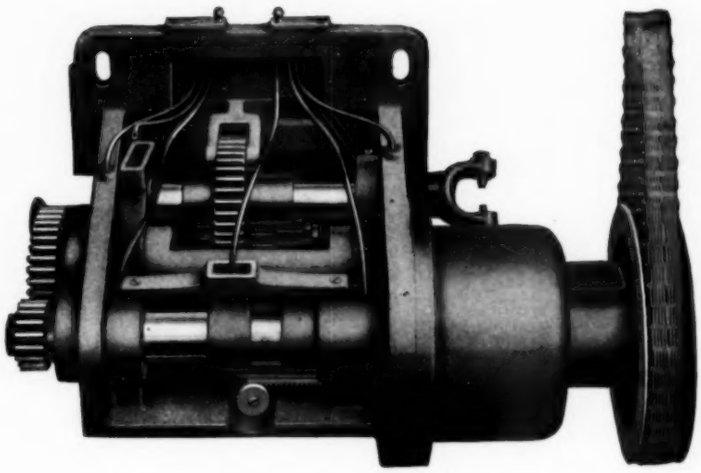
The following facts show how the high efficiency is obtained in the speed and feed cases of

B. & S. Constant Speed Drive Milling Machines



Feed Case—Interior.

1. All of the supporting parts, shafts and gears, are heavily proportioned so that all vibration is eliminated, even when the machine is taking heavy cuts.

2. Ample oiling facilities for the bearings are provided in a simple and direct manner by two reservoirs, as shown in the cuts.

3. The special design of the gears, made with pointed teeth and chamfered edges, assures instant engagement without the employment of auxiliary mechanism.

4. All gears are of machinery steel, hardened, and with the holes ground concentric with the pitch circles after hardening.

5. The shafts are also hardened, of steel ground and supported firmly close to points where pressure is applied.

6. Changes in feeds and speeds are made by a simple shifting of levers. The plates that show the different arrangements of gears for the various feeds and speeds have no confusing combinations of letters and numbers to be considered.

Speed Case—Interior.

Send for "Features of the Original Constant Speed Drive Milling Machines."

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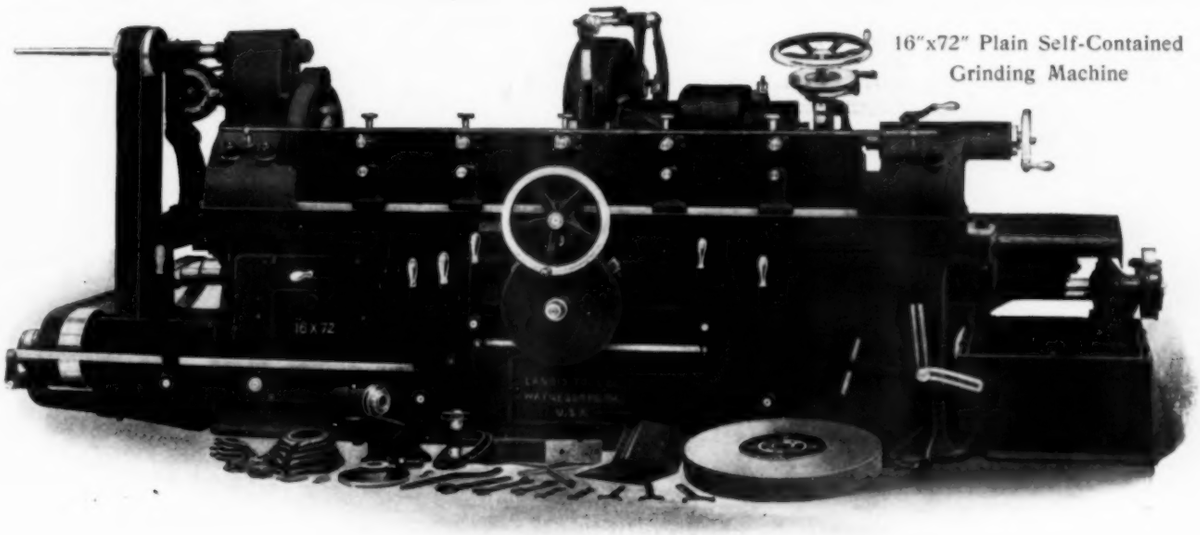


16"x72" Plain Self-Contained Grinding Machine

The Grinding Wheel Carriage Is The Traversing Member

This is *one* feature which distinguishes **Landis Grinding Machines** from all other makes. And the advantages of this principle are as follows:

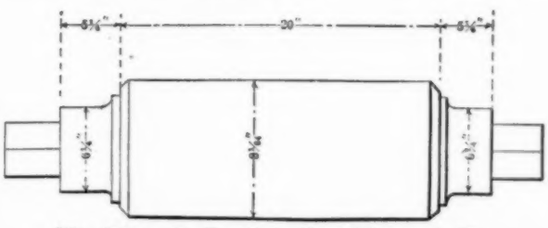
Unvaried duty imposed at all times upon the carriage-driving mechanism, ensuring accuracy of traveling distance between points of reversal; uniform and positive lubrication of the ways; a rigid and stationary foundation for the work whatever its length or weight; no over-hanging of the work table, it being supported its entire length by the main column of the machine to which it is firmly clamped—thus avoiding vibration—a feature which is so essential to rapid and accurate grinding.

The Landis Machine shown is a *manufacturing machine* in every sense of the word. It is primarily intended for finishing cylindrical work, such as straight and taper spindles, shafts, pistons, corliss valves, plungers, tubing, etc.; but it is also especially adapted for grinding hardened steel and chilled iron rolls.

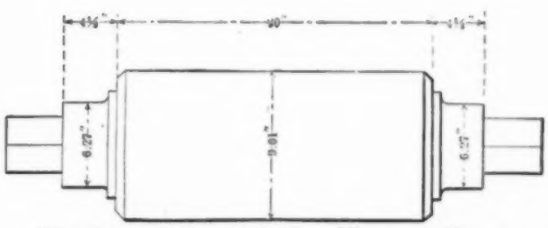
The work and traverse speeds are varied and operated independently of each other, an important factor in commercial grinding, giving the necessary traverse feed for any work speed.

Write for catalog "A" and learn the full particulars.

Examples Of Roll Grinding Work



Tin Plate Roll—Grinding Time 1½ Hours. Material, Chilled Gray Iron. Stock removed, .030" Diameter. Variation Allowed, .001".



Tin Plate Roll—Grinding Time 1¾ Hours. Material, Chilled Gray Iron. Stock Removed, .030" Diameter. Variation Allowed, .001".

Landis Tool Company, Waynesboro, Pa.

New York Office, Fulton Building, 50 Church Street, Walter H. Foster & Co., Managers.

AGENTS—C. W. Burton, Griffiths & Co., London and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Barcelona and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

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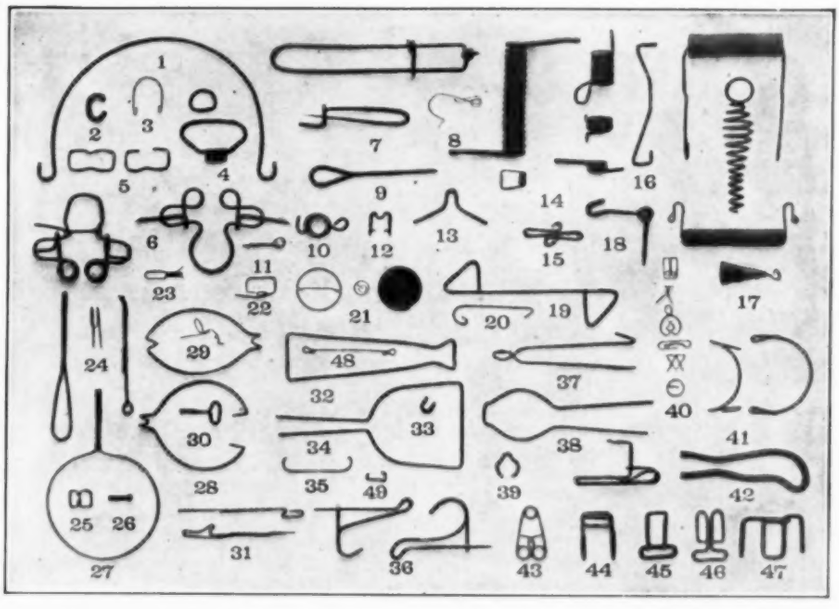

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Machines Do Work Like This At Wonderful Speed

1 Bail for buckets; 2 Link; 3 Choker wire; 4 Handles for tinware; 5 Suspender loop; 6 Calf weaners; 7 Can openers; 8 Special spring; 9 Button hook blank; 10 Wire tie; 11 Special; 12 Wire clamp; 13 Bottle wire; 14 Coil springs; 15 String cleat; 16 Special; 17 Package and lifter handles; 18 Hook and eye; 19 Special shape; 20 Trap spring; 21 Harness and button rosettes; 22 Tag fastener; 23 Special loop; 24 Wire loop; 25 Wire buckle; 26 Oil can and bucket ears; 27 Net rings; 28 Bed spring fabric; 29 Special; 30 Can key; 31 Bag and Hay bale wires; 32 Wire handle; 33 Fence clip; 34 Wire frame; 35 Link; 36 Hat and coat hooks; 37 Special hook; 38 Egg beater frame; 39 Bottle wire; 40 Paper clips; 41 Neck wire; 42 Handle; 43 Clothes pin; 44 Cotton tie; 45 Cotton tie; 46 Wire hook; 47 Bale tie.

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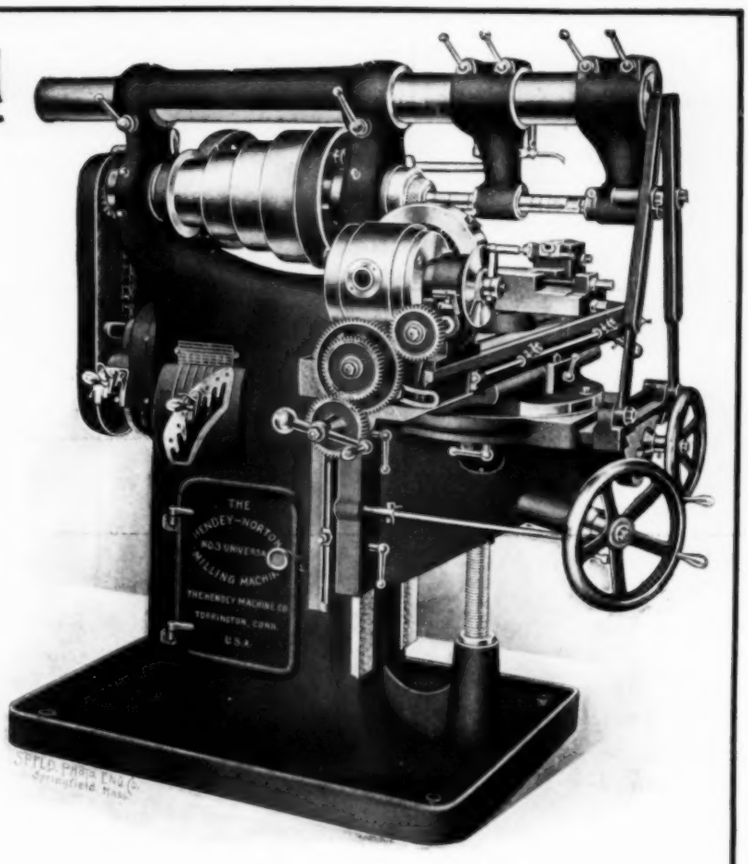

FEEDS 30x10x19" all automatic, with positive roller chain drive. Working surface of table, 48¾"x11". Main spindle has taper journals running in annular bearings fitted with ring oilers. Knee rigidly braced and has projected bearing on column of machine. Elevating screws telescopic. Table feed screw fitted with ball bearing thrust. Dividing head spindle travels through an arc of 216 degrees. Head has tool steel worm running in oil bath. Is tested for accuracy in divisions on an 8" diameter plate. All feeds and reverse of same within easy control from front of knee.

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Fully guaranteed.

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Torrington, Conn., U. S. A.

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Cutters with Inserted Teeth Teeth of Carbon or High Speed Steel

We have made a number of changes in the design of these cutters and our latest and most improved cutters are unrivaled as result producers.

They are adapted for heavy work and will stand up under extraordinary conditions.

The locking device for the teeth is the most positive we know of.

We have known of cases where accidents have happened which put fixtures and arbor out of commission and twisted cutter but we never knew a tooth to move or become loosened.

Prices quoted on request.

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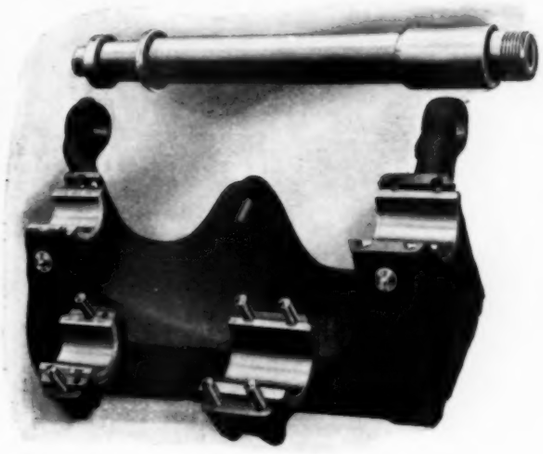

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Our spindle bearings are not ideal, but nearer to it than any bearing ever used on a Lathe before.

The journal is hardened and ground, and runs in a special cast iron box.

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The R. K. LeBlond Machine Tool Co.

Cincinnati, Ohio.

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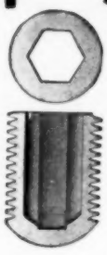

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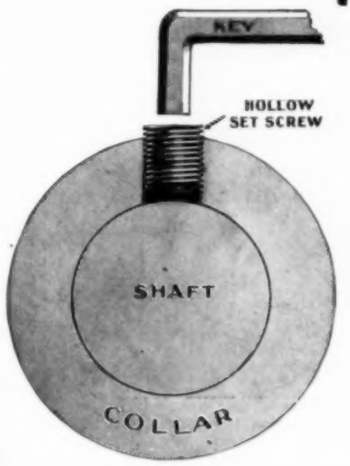

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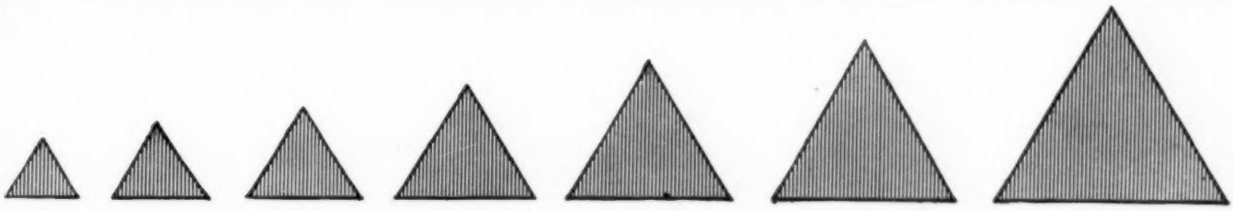

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